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Charles River
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MAIN REPORT
&
ATTACHMENTS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION • CORPS OF ENGINEERS
WALTHAM, MASS. 02154

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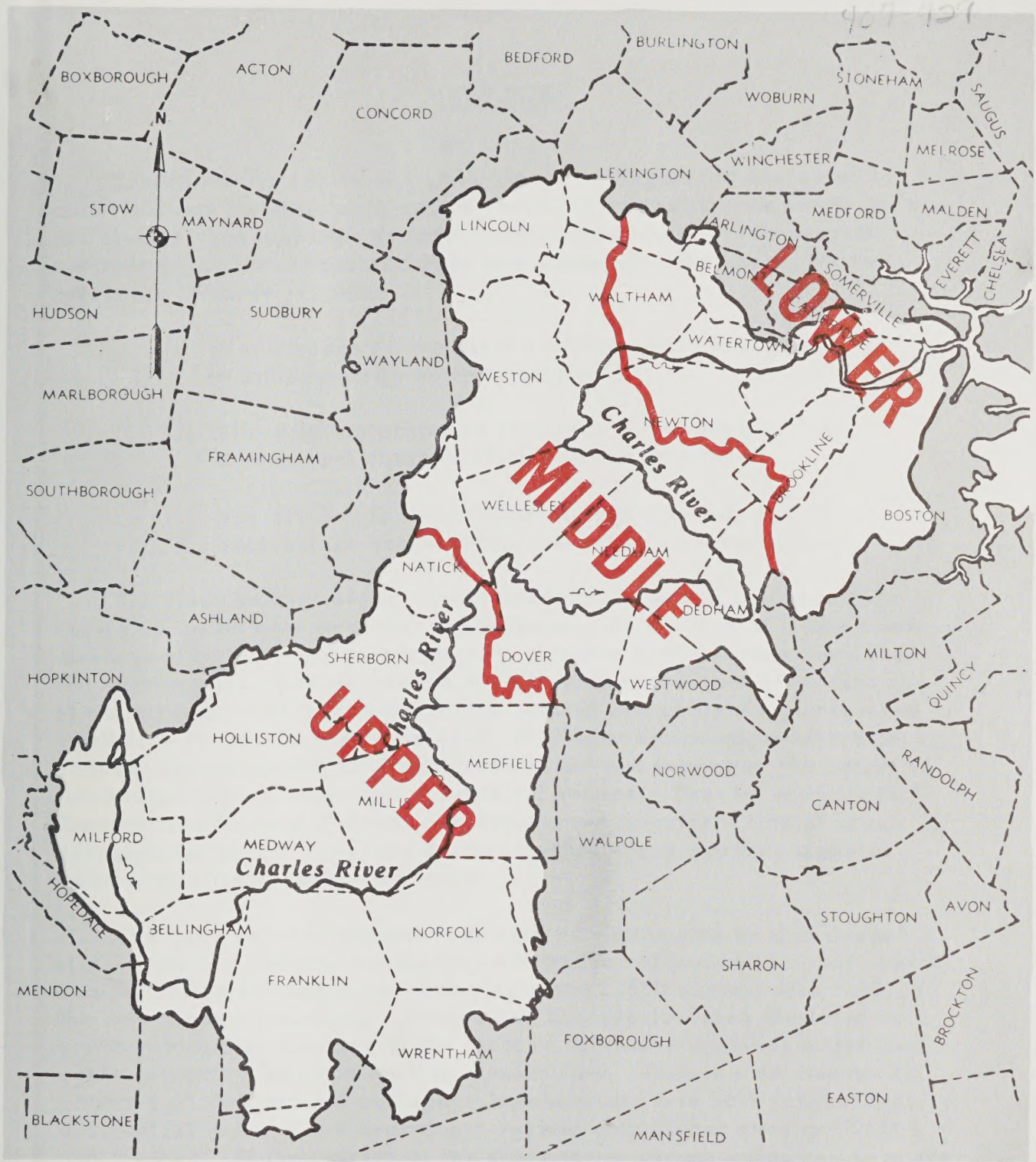

CHARLES RIVER WATERSHED

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

0 5

SCALE IN MILES

PREFACE

Traditionally, the U. S. Army Corps of Engineers has acted to solve serious flooding problems by building control works which have not always been met with uniform public enthusiasm. The project recommended for authorization in this document, therefore, is remarkable in three respects.

(1) It addresses an incipient problem early enough to implement an optimal solution.

(2) The solution proposed is unique to the physiography and natural characteristics of the watershed.

(3) The project is the product of open planning and as such enjoys broad public and private sector support.

The flood control aspect of the coordinated water resource plan drawn up in the course of this study focuses on two areas -- the Lower Basin pool of the Charles serving the Greater Boston urban core and the Middle and Upper watershed.* The extreme downstream shores of the stream are already densely populated and completely urbanized. Upstream areas, on the other hand, still have options open which could prevent encroachment on flood-prone areas and minimize the extent of future flooding on lands now considered secure. That is, with local, Commonwealth, and Federal cooperation the inevitable tide of urban development which threatens upstream open space can be channeled away from irreplaceable wetlands.

The flood control management plan recommended by this Corps' study calls for Federal acquisition and perpetual protection of 17 crucial natural valley storage areas totalling some 8,500 acres. The logic of the scheme is compelling. Nature has already provided the least-cost solution to future flooding in the form of extensive wetlands which moderate extreme highs and lows in stream flow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millenia undisturbed. In the opinion of the study team, construction at any of the most likely alternatives, a 55,000 acre-foot reservoir, or extensive walls and dikes, can add nothing.

* See the Interim Report of 1968 for the recommendations of the Division Engineer with respect to the Lower Charles River Watershed.

But this enlightenment alone will not do the job. The public is rarely motivated to act on high principle unless demonstrable benefits accrue to its investment. Particularly because the Middle and Upper Charles is so close to a major metropolitan area and its wetlands are so tantalizingly ripe for suburban sprawl, the returns on the Corps protection proposal become critically important. First, of course, are the long-term flood control effects which wetlands acquisition will perpetuate. But more urgent in terms of needs articulated by watershed people themselves is the safeguarding of natural areas as green space for human relaxation and sanctuary for wildlife.

Quite apart from blue-sky aspirations for the total environment, the Commonwealth and the public together recognize that the project serves immediate recreational interests. Intelligent management of the acreage recommended for protection can provide space-starved urban populations with access to natural areas. Host towns need not resign themselves to the bedlam and macadam monotony of uncontrolled urbanization. For once, the environment need not be compromised.

This report presents the least costly and best alternative of those considered for flood control for Congressional consideration. All the expenditures contemplated are not to build but to preserve. As a blueprint for maintaining environmental integrity, the Charles River Watershed plan is a test of commitment.

CHARLES RIVER STUDY

MAIN REPORT

ERRATA SHEET
September 1972

1. Change the Table number on page 56 to 10 in lieu of 9.

2. Change the title of paragraph 2, page 47, to The Middle and Upper Charles.

3. Change third sentence of the second paragraph, page 57 to ... National Wildlife Refuge Program....

4. Change the numeral on the first line, page 64, to 477,000 in lieu of 447,000.

5. Change the numeral in Table 15, page 66, to 477,000 in lieu of 447,000.

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F	Impoundments and Tributary Watersheds
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H	Flood Management Plan Formulation

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO

NEDED-R

28 April 1972

SUBJECT: Water Resources Development Plan, Charles River Watershed, Massachusetts

HQDA(DAEN-CWP-D)
WASH D C 20314

PART I: REPORT PREPARATION

A. AUTHORITY

This report is submitted in final response to the following resolution of the Committee on Public Works, House of Representatives of the United States, 24 June 1965:

> "That the Board of Engineers for Rivers and Harbors is hereby requested to review the report on Land and Water Resources of the New England-New York Region printed in Senate Document Numbered 14, 85th Congress, First Session, with particular reference to the Charles River Basin and tributaries, Massachusetts, with a view to determining the advisability of improvements in the interest of flood control, water supply, recreation, water quality control, navigation, tidal flood control, allied purposes, and related land resources."

B. SCOPE

Begun in 1967, the Charles River Watershed[1] study proceeded in two phases. The first subject of study was the Lower Charles River, an intensely urbanized area where the threat of serious flooding is greatest and the need for protection is most urgent. The findings of that investigation are documented in the Interim Report on the Charles River for Flood Control and Navigation submitted 29 May 1968. The recommendation of the Division Engineer included a pumping station and three navigation locks at Warren Avenue, Boston, which have since been authorized by Congress and are under design. When completed, this project will solve the immediate problem of flooding from rapid urban runoff in the Lower Basin.

The second portion of the Charles Study considered the watershed as a whole, expanding the areal scope from 57.6 square miles to include the Middle and Upper Charles drainage areas. The present report documents the results of survey scope studies covering flood control, navigation, environmental preservation, aesthetics, recreation, water supply and pollution control for the 307 square miles of the Charles watershed shown in the frontispiece. In all cases, water and related land resources have been taken into account through the year 2020.

During the course of the study, full use was made of plans, reports, and cartographic materials prepared by Federal, State and local agencies. Particularly valuable were the resources of private sector institutions. For example, the Peabody Museum of Harvard University in cooperation with the National Park Service explored the known and suspected archeological sites in the watershed, reviewed area geology, and consulted both public and private collections to prepare a report supplied to the Corps of Engineers. Moreover, the Corps made use of computer analyses developed as part of graduate fellowship programs at Harvard University and the Massachusetts Institute of Technology;

---

1 An impoundment formed by the Charles River dam located near the mouth of the river is known locally as the Charles River Basin. To avoid confusion, the entire area draining to the Charles River has been referred to throughout the study and in this report as the "Charles River Watershed".

1) evaluation of the operation of the Cambridge water supply system in the Stony Brook subwatershed, and 2) the feasibility of constructing impoundments for low flow augmentation. The reporting officer and members of his staff have conducted field reconnaissance in problem areas, noting sites for potential improvement. Data obtained from all sources have been analyzed and correlated by in-house engineering studies.

C. PROJECT INPUTS

1. Federal

• There are no previous reports by the Corps of Engineers specifically addressed to flood control and navigation in the Charles River watershed. However, Part Two, Chapter XVI of Land and Water Resources of the New England-New York Region [2] included basic material on water management and water quality in the Charles area gathered by the New England-New York Inter-Agency Committee (NENYIAC).

• A letter-type (unpublished) report, Reconnaissance Report - Local Protection, Muddy River, Boston-Brookline, Massachusetts, was submitted to the Chief of Engineers on 21 April 1966 pursuant to authority contained in Section 205 of Public Law 87-874, adopted 23 October 1962. The report includes a description of the area, presents material on stream characteristics, and discusses the flood problem in this tributary watershed. Because of the cost limitation contained in the enabling legislation, and the close relationship between flood stages on the Muddy and Charles rivers, the report recommended that flood protection investigations of the Muddy River be integrated with the current Charles River study.

• The Environmental Protection Agency has reported on the chemical, physical, and biological characteristics of the Charles and commented on the benefits possible with flow augmentation. This material has been incorporated in the report as Appendix E, Water Quality.

• The Soil Conservation Service, Economic Research Service, and the Forest Service, three agencies of the U. S. Department of Agriculture, have participated in the Charles Study within the framework and resources of on-going programs. Their findings are documented in Appendix F, Impoundments and Tributary Watersheds.

2. Regional

• Close contacts have been maintained with the New England River Basins Commission, the agency established in the Water Resources Planning Act of 1965 to coordinate the development of comprehensive

2 Senate Document Number 14, 85th Congress, First Session.

plans for water and related land resources in the New England region. NERBC staff assisted in preparing public presentations throughout the course of the study. It bears special note that the project proposed by the Corps of Engineers in this report is fully compatible with on-going studies which are part of an NERBC Level B comprehensive framework study for Southeastern Massachusetts and Rhode Island. Indeed, the findings of the Charles River Study are likely to be adopted as an important adjunct to the Commission's investigation.

- The Metropolitan Area Planning Council (MAPC) has issued several reports covering space planning, economics, solid waste disposal, water and sewer facilities and housing for its subject area. Results of the Water Supply and Sewerage Studies prepared by Camp, Dresser & McKee for MAPC are summarized in Section B, Part III.

The Metropolitan District Commission (MDC) has been responsible for the greatest number of reports pertinent to the water and water-related land resources of the Charles River watershed; recreation, flood control, sewage disposal, water supply, etc. It has also contracted with Architect-Engineer firms to study pollution abatement projects in certain reaches of the river.

3. State

- The Massachusetts Department of Natural Resources has published numerous reports on topics within its field of responsibility; conservation, fisheries, water quality management, etc. Specifically, the DNR report, Outdoor Recreation and Environmental Conservation in the Charles River Watershed, together with comments supplied by the Federal Bureau of Outdoor Recreation (Appendix G) form the recreation portion of the watershed plan presented here.

4. Municipal

- Materials provided by the Boston Redevelopment Authority have been reviewed and incorporated as appropriate.

- The Corps has frequently consulted local officials in the 35 cities and towns of the watershed, including:

Commissioners of Parks and Recreation
Boards of Selectmen
Planning Boards
Conservation Commissions
Water Boards
Sewer Commissioners
Town Forest Committees

Where available, comprehensive planning documents have been reviewed.

5. Private Sector

- Four non-governmental bodies also provided the Corps with valuable assistance:

Charles River Watershed Association
Massachusetts League of Women Voters,
Charles River Group
Massachusetts Audubon Society
Trustees of Reservations

D. PROJECT COORDINATION

Two groups organized specifically for the Charles River Watershed Study provided the Division Engineer with support and guidance[3].

Coordinating Committee: a 10-member body representing all the major Federal, State and regional agency participants in the Charles study. Nine public meetings of the Committee were held, each major topic of study being first reported on by one or more of the agency representatives and then discussed by all participants. Any questions pertinent to the Corps' investigation were welcome subjects of discussion. Further, the Committee made a particular effort to meet with parties unfavorably disposed toward the study and to establish a common ground for cooperation.

Citizens' Advisory Committee: a body of more than 30 private citizens who collectively represented the industrial, conservationist, educational, recreational and real estate interests of the watershed area. Organized under the direction of Nathan M. Pusey, former President of Harvard University, the Advisory Committee assisted the Corps in the following areas:

- Expertise in civic affairs
- Specialized knowledge in substantive areas
- Recommendations on project planning
- Proposals for allocating responsibility for project implementation
- Liaison with the broadest possible sector of the general public

As ombudsman for the watershed residents, the Citizens' Advisory Committee acted as a sounding board for a variety of study proposals. Moreover, it sponsored 12 informational meetings in communities throughout the Charles Watershed. Held between April and May, 1971, these presentations were intended to acquaint local officials and

3 See Appendix A, Conduct of Study for full particulars on the structure and function of these bodies.

townspeople with the results of Corps and Soil Conservation Service investigations. By encouraging comment, the Corps sought to improve its product through a measure of open public planning. In every instance, local residents responded energetically; more than 600 appeared to evaluate the potentials in the watershed and then to pose questions from the floor. These sessions made a direct contribution to the study in helping to formulate the final recommendations made in this report.

In general, most public spokesmen emphasized the need for the preservation of an open space corridor or greenbelt along the floodplain and recreational opportunities contingent on improvements in the quality of Charles water. From the testimony heard at the last of a series of public meetings, it appears that the non-structural flood control plan presented by the Corps has widespread public support.[4] Indeed, the project has received considerable attention as an innovative and eminently reasonable approach to a whole range of problems perceived in the Charles area. Implementation of the recommendations presented here offers the watershed population as a whole impressive long-term benefits quite outside the issue of flood protection. The public is anxious to see multiple returns on its investment in the Charles.

4 See Appendix A, Section 6 for a digest of the proceedings at Medfield, 13 May 1971.

CHARLES RIVER STUDY COORDINATION

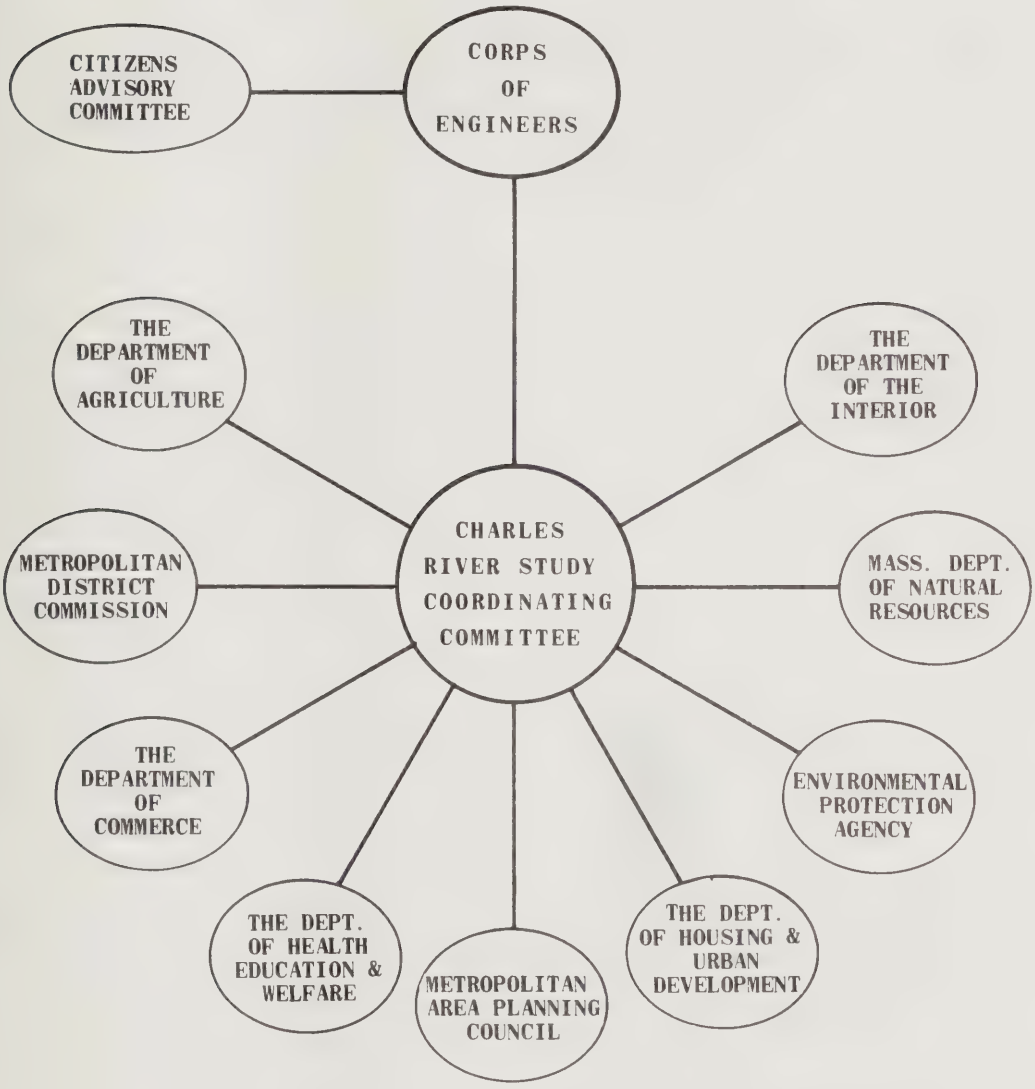

CITIZENS ADVISORY COMMITTEE
CORPS OF ENGINEERS
THE DEPARTMENT OF AGRICULTURE
THE DEPARTMENT OF THE INTERIOR
METROPOLITAN DISTRICT COMMISSION
CHARLES RIVER STUDY COORDINATING COMMITTEE
MASS. DEPT. OF NATURAL RESOURCES
THE DEPARTMENT OF COMMERCE
ENVIRONMENTAL PROTECTION AGENCY
THE DEPT. OF HEALTH EDUCATION & WELFARE
METROPOLITAN AREA PLANNING COUNCIL
THE DEPT. OF HOUSING & URBAN DEVELOPMENT

Figure 1

PART II: THE GEOPOLITICAL FRAMEWORK

A. WATERSHED PROFILE

Like any watershed, the Charles is an instrument of nature. Despite the welter of jurisdictions crowded between its borders, the water and land first obey the regimens established by hydrologic and geologic law. Without regard to the politics of man, the watershed is an entity of itself.

1. Location and Size

Extending inland from Boston Harbor southwesterly toward the Massachusetts-Rhode Island border, the Charles watershed has an hour-glass shape covering 307 square miles. Along its longitudinal axis, it measures 31 statute miles while the River itself meanders some 80 miles from its headwaters to its mouth. Abutting watersheds in counterclockwise order are the Mystic, Merrimack, Blackstone, Taunton, and Neponset.

2. The River

The Charles River rises at an elevation of 500 feet in springs on the southerly slope of Honey Hill about a mile from Hopkinton Center. One mile downstream and nearly 150 feet lower is Echo Lake, often called the source of the Charles. In the Middle and Upper reaches, the stream has seven major tributaries:

Hopping Brook. From its source in the town of Holliston, this tributary flows in a general southerly direction through a moderately hilly area to its mouth at the Charles River in the town of Bellingham. It has a total fall of about 120 feet in its 8-mile length and a drainage area of 11.5 square miles.

Mine Brook. This 12-mile tributary rises in the southwestern part of the town of Franklin and flows first northeasterly for about 8 miles, then westerly for a short distance and northerly for about 4 miles. Its confluence with the Charles is at the northerly edge of the town of Franklin. The brook includes numerous large ponds along its length. It falls about 160 feet and has a drainage area of 15.7 square miles.

Mill River. The Mill River flows northerly from the town of Wrentham for about 7 miles to its confluence with the Charles in Norfolk. In its fall of about 150 feet it drains 16.3 square miles. Lake Pearl and Lake Archer, located in the upper reaches of the tributary, are relatively large bodies of water.

Stop River. Stop River rises in the town of Norfolk and winds in a general northerly direction for about 7 miles to the Charles River in the town of Medfield, descending 100 feet in its course. With a drainage area of 17.1 square miles, this stream is characterized by a wide, swampy area at its mouth.

Bogastow Brook. This largest tributary of the Charles River drains 25.5 square miles. From its source in Holliston, the stream flows 9 miles generally to the southeast, turns northerly at Great Black Swamp, and travels northeasterly for about 3 miles to its confluence with the main stem in the town of Millis. The tributary basin contains numerous large ponds, notably Lake Winthrop. Extensive swampland along the downstream portion of the brook provides a large natural storage area.

Waban and Fuller Brooks. Waban Brook originates in the town of Weston; Fuller Brook in Wellesley. They join in Wellesley about 600 feet above the confluence with the Charles. The Waban basin includes Nonesuch Pond, Morses Pond and Lake Waban. Waban Brook has a length of 6 miles in which it falls some 90 feet. Fuller Brook has a length of approximately 2 miles and falls 20 feet. Their total drainage area is 16.1 square miles.

Stony Brook. Stony Brook is the second largest tributary in the watershed. It flows from Sandy Pond in Lincoln approximately 7 miles in a southeasterly direction and enters the Charles River in Waltham. The brook has a total fall of about 170 feet and drains 23.6 square miles. The City of Cambridge obtains most of its water supply from the Hobbs Brook and the Stony Brook Reservoirs. Management of these impoundments effectively controls the entire tributary watershed.

3. The Land

The Charles River drainage area is located within the Seaboard Lowland of the New England physiographic province. The Lowland is a seaward sloping, irregular surface of low relief mainly underlain by

crystalline rocks. The pre-glacial maturely eroded rock surface has been considerably modified by glacial deposition.

The course of the Charles River is governed only in a very broad sense by the underlying rocks; i.e., the rock-fault basin of Boston is the basic reason for the existence of a stream flowing northeast from the southwest quadrant of that region as one arm of a radial drainage pattern. The short length of the river is attributed also in a very general way to the nature of the surrounding hardrock territory which is essentially an old eroded surface planed off. The irregular old hardrock surface, its depressions glutted with glacial debris, is not conducive to the development of long, free-flowing streams. The short stream of the Charles River has been able to achieve quick maturity because it lies mostly on unconsolidated glaciomarine and outwash sediments, with only its upper reaches on the more resistant glacial till and bedrock upland. Surficial materials have influenced the course of the river, with resistant till and rock hills serving as points of deflection which have created meanders.

Upstream of Waltham in the Newton Lower and Upper Falls sections the terrain is moderately hilly and farther upstream above the South Natick Dam, one sees bluffs rising over 200 feet at the outer curve of river meanders. The extensive flood plain of the Medfield-Millis "marshes" is found in the central portion of the watershed. Low, flat terrain extends farther up the course of the river, into Medway in the south central portion. Toward the western fringe of the watershed, hills predominate, and several summits along the perimeter reach over 500 feet above sea level. The terrain of the lower portion of the watershed is generally flat to gently rolling. In an area extending upstream about six miles above the river's mouth and inland about one mile from both banks in Boston and Cambridge, ground elevations range from below 10 to some 50 feet above mean sea level.

Most of the Charles River and its tributaries are carved into glacial overburden, essentially the only material overlying bedrock inasmuch as residual soils were removed by intensive Pleistocene glaciation. The bedrock depression of the Boston Basin allowed marine invasion during the Pleistocene glacial epoch and the deposition of the Boston Blue Clay, fine materials which attain thicknesses of well over a hundred feet. The silts and clays are also encountered several feet

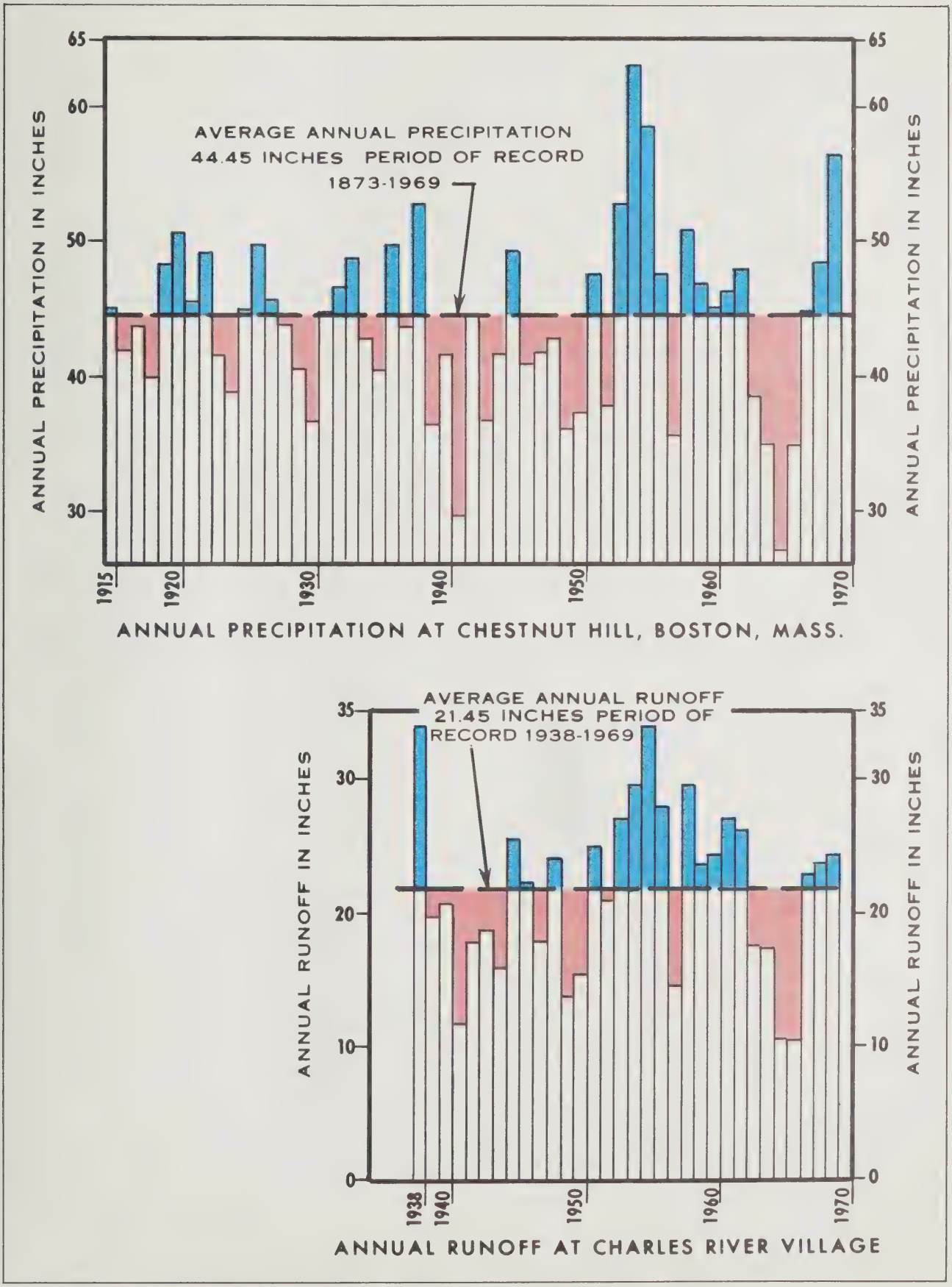
below sea level wherever a depression of sufficient depth has a connection to the sea. Outwash deposits flank bedrock-controlled hills in some areas but the predominant overburden is a dense glacial till plastered on eroded rock hummocks and ridges. Many of these till-covered hills were streamlined by glacial movement and shaped like inverted teaspoons -- famous drumlins which dot Boston Harbor and shelter it from the sea. Recent deposition consists of stream and swamp deposits and, in the Lower Basin, harbor mud.

4. Climate

The watershed lies within the climatic zone called "humid" and, as in most of New England, the climate is variable. It is characterized by a wide range of temperature and frequent but usually short periods of precipitation. The watershed lies in the path of the prevailing westerlies and air masses move over it predominantly from the interior of the country. Generally west to southwest airflow brings hot, dry weather which is responsible for occasional summer droughts. The area is also exposed to the coastal storms of tropical origin; that is, hurricanes which travel up the Atlantic seaboard as well as storms of extratropical nature known as "northeasters".

The watershed climate has an average temperature of 49°F, derived from a range of about 50° at the coast to about 48° at the higher elevations. However, average monthly temperatures vary widely throughout the year; between a range of 70° to 72° in July and a range of 25° to 28° in January. Due to urbanization, Boston's means are slightly higher. Extremes occasionally reach slightly over 100° and below minus 20° Fahrenheit.

The average annual precipitation over the watershed is 44 inches distributed uniformly throughout the year. Records indicate that slightly less rain falls at the Framingham National Weather Service station than at Walpole. However, the average difference of less than 2% is hardly significant. A record amount of rain fell in 1888, with the Weather Bureau recording 60 inches. By contrast, as Figure 2 indicates, less than 29 inches fell in 1965. There have been two extended periods of less than average precipitation in the watershed, one in the 1940's and the other in the mid-1960's. The annual snowfall over the watershed ranges from about 45 inches near the coast to 55 inches at the



CHARLES RIVER PRECIPITATION AND RUNOFF

FIGURE 2

higher elevations of the central and southern portion. The water equivalent of the snow in early spring ranges from an average of 3 inches to a maximum of 6 inches in upland areas.

5. Storms and Droughts

Two types of storms assail the watershed; cyclonic storms or "lows" from landward directions, usually the west or southwest, and coastal storms. Lows bring frequent periods of unsettled but seldom extremely severe weather. The more severe storms of record have had a marine trajectory, including the "northeasters" on the colder season and the tropical storms of late summer and fall. Of these two types, tropical storms are usually the most damaging. They can travel rapidly up along the Atlantic coast to within striking distance of the watershed.

The watershed has experienced six recent storms of note; in March 1936, July 1938, September 1954, two in August 1955, and in March 1968. All but the storm of September 1954 produced or contributed to major flooding. Rainfall in the Hurricane Diane storms of August 17-20, 1955, ranged from 10 to 15 inches over the watershed. In addition to these floods resulting from rainfall, recent serious flooding was produced by excessive snowmelt in March 1969. Although records are meager, available information indicates that the greatest flood prior to 1900 took place in February 1886 and possibly exceeded the flood of 1955. Other floods of note occurred in 1807 and 1818.

A drought is a prolonged precipitation deficiency which seriously affects both river flow and surface water supplies. The watershed has experienced two periods of such deficiency in recent times; 1939 through 1949 save one year, and 1962 through 1967. The drought in the mid-1960's resulted in the lowest sustained flows of record in the Charles River. Figure 2, showing the years 1938 to 1969, graphically demonstrates the close correlation between precipitation and flow in the Charles River. Given the growing concentration of population in the watershed, it is reasonable to expect that future droughts of the same proportions will produce greater hardship.

6. Reaches of the Charles

To the average mind, the Charles is more nearly a work of man than nature. Spanned by more than 100 roadways, dammed at 20 points

along its course, the river has been made and remade many times to suit the human needs of the day. In fact, without the mill and power dams to create width and depth, the upper river would be virtually unnoticeable during much of the year. And in the lower river, the lovely Basin reflecting pool created early in the century by the construction of Leverett Dam (Charles River Dam) was formerly an unsightly and malodorous tidal estuary. This much-molded river, enjoyed by millions as a ribbon of open space threaded through the urban sprawl of the immediate Boston area, has reaches defined by physical structures rather than natural physiographic features. As the frontispiece shows, the Charles can effectively be divided into three subbasins, each with its distinctive environment.

Upper Charles

Reach 1: The extreme upper reach of the Charles extends from Echo Lake to Populatic Pond on the Franklin-Norfolk line, a distance of 20 miles in which the river falls some 220 feet. The mainstream flow is interrupted by nine dams, many of which were built by riparian mill owners as power sources. The environs are largely woodlands interspersed with small manufacturing towns and farms.

Reach 2: The 12 miles between Populatic Pond and Route 27 embrace the largest Charles natural valley storage area, the so-called "marshes" of the Upper Charles. In this and the next two downstream reaches, the river flows at very low gradient -- an average of only one foot fall per mile. As an area of natural flood water storage and wildlife habitat, this reach acts as a huge sponge which substantially modifies flood flows in the mainstream.

Middle Charles

Reach 3: Below Route 27 to the South Natick Dam, the wide marsh area narrows and pine-forested banks rise abruptly from the river shore. These six miles of riverway are largely in estate or trust ownership. All Metropolitan District Commission property falls downstream of this reach.

CHARLES RIVER
LOOKING UPSTREAM AT WEST MEDWAY DAM

NATURAL VALLEY STORAGE
NOTE WIDTH OF CHARLES RIVER DURING NORMAL FLOW

MEDFIELD - MILLIS WET MEADOW

NORMAL SPRING HIGH WATER

Reach 4: The secluded estate character of the river upstream of the South Natick Dam changes gradually from expensive suburban land, thence to sweeping lawns and finally to urban development as the river approaches Silk Mill Dam. In this 11-mile stretch lies the second largest natural valley storage area -- "The Dedham Loop" -- and the Mother Brook Diversion, where one-third of the Charles' flow is diverted to the Neponset River.

Lower Charles

Reach 5: From Silk Mill Dam to Watertown Dam, the Charles drops 75 feet in 10 miles, principally at seven dam sites. Within this reach one finds sharp contrasts in the aesthetic quality of the riverscape. Above the Moody Street Dam a large reservoir lies in a stately natural setting. Though it was heavily used by recreationists early in this century, today the pool is grossly polluted. Downstream of Moody Street, the river flows in a confined channel beside ancient factories, ramshackle warehouses, an isolated recreation area, a dump and adjacent shopping centers.

Reach 6: The river downstream of the Watertown Dam, known locally as the Charles River Basin, is formed by the Charles River Dam located 1.2 miles above the mouth of the river. The Basin is 8.6 river miles long and covers some 675 acres at its design water service level of 2.38 feet above mean sea level. The major portion of the basin downstream of the Boston University Bridge has a length of 2.6 miles and widths varying from 300 to 2,000 feet; the latter width prevails throughout the central 1.5 miles of this reach.

Historically, the view across the Basin with sailboats in the foreground and Beacon Hill and the State House dome dominating the background has symbolized the City of Boston. The banks of the Basin offer paths for bicyclists and pedestrians, grassy areas for sunbathing, totlots, tennis courts, and the "shell" for outdoor concerts. Its waters support community sailing programs for thousands from teenage up. It also accommodates college rowing and general recreational power boating. As one of the world's most used and enjoyed urban waterways, the Charles Basin provides a high quality visual experience for adjacent populations.

In sum, then, the volume and configuration of the Charles is greatly modified by two factors, 1) the numerous dams which widen the mainstream and slow its pace, and 2) the extensive natural storage provided by wetland areas in the Middle and Upper watershed. Flood peaks in these areas are so retarded by natural valley storage that they do not reach the Lower Charles until three to four days after the flood peak generated downstream has passed. But for this characteristic, the Charles watershed would have suffered much greater flood damage many times in the past. And, not only do upstream wetlands buffer the effects of high flow periods, they also mitigate the consequences of low flow and extended drought. By releasing their stored waters gradually in the summer months, stream flows are naturally sustained through periods of low precipitation. The "swamp" land thought by too many to be useless unless developed, is, in fact, a superb control mechanism for the regimentation of the river.

CONFLUENCE CHARLES RIVER AND MOTHER BROOK DIVERSION

CHARLES RIVER
DEDHAM - WEST ROXBURY

CHARLES RIVER

WELLESLEY- NEWTON

CHARLES RIVER
WALTHAM

CHARLES RIVER
WATERTOWN

LOWER CHARLES RIVER
CHARLES RIVER BASIN

B. A DEVELOPMENT OVERVIEW

Unfortunately, though, it appears that the natural areas in the Upper and Middle Charles will not be able to meet growing flood protection needs much longer. The reason is simple; development continues to encroach on wetlands, at once reducing their total acreage and their storage capacity. The unchecked momentum of municipal growth is threatening the flood safety of the Charles River communities. This is not to say that development is inherently evil. Indeed, the historical evolution of the watershed argues to the contrary.

1. History

Champlain was likely the first white man to see the Charles River, though there is a possibility that the Norseman Leif, son of Eric the Red, explored it in the 11th century. Captain John Smith named the river for Charles I of England and interested that monarch in its potential for trade and settlement. The early history of the watershed typifies a pattern often repeated in the settlement of the New World. The frontier offered the opportunity to acquire land, wealth, and freedom from political and religious oppression. The Charles spurred this movement inland by providing a water highway to the interior.

The Charles River was the first river to be colonized by Englishmen in the region. In 1630, those members of the Bay Company who found Salem too crowded and Charlestown water-poor sailed up the Charles to fertile lands above Cambridge. Soon, other settlements sprang up and within 45 years of the initial Bay Company settlement, a total of 12 had appropriated some 75 miles of the 80-mile river; Charlestown, Boston, Roxbury, Dorchester, Watertown, Cambridge, Dedham, Natick, Sherborn, Medfield, Mendon, and Wrentham. As it drew population, the river also encouraged the growth of trade and industry. A grist mill was built on the Charles four years after the founding of Boston and by the early 1800's goods from saw blades to chocolate were being produced along the river.

But for all their Puritan industry, the citizenry also found time for the less mundane aspects of social evolution. Deeply affected by the challenge of a new land, they became a tough-minded people, aggressively self-reliant and engrossed in the philosophy of their political and religious life. In fact, the Charles River Watershed is distinguished by the flowering of several intellectual movements.

- Reverend John Eliot, minister to the Indians, espoused brotherhood among the races. Natick, the first of his "praying towns", was established in 1651.

- The first elected selectmen in New England took office in Watertown in 1634. In a period when the persecution and execution of Quakers and "witches" were commonplace, the democratic citizens of Watertown gave haven to dissident religious voices.

- John Wise (1652-1725) clearly enunciated the democratic principals developing in the Colonial Church in his Vindication of the Government of New England Churches. The institution of the New England town meeting first practiced in the watershed town of Cambridge survived and became the model of representative government for every community in the State.

- Ralph Waldo Emerson, Theodore Parker, Bronson Alcott, etc., were all part of the Charles watershed phenomenon called Transcendentalism. Convinced of the intrinsic value of consicence and intuition, they organized the first white American experiment in communal living at Brook Farm in West Roxbury.

This intellectual stamp endures today. Beginning with the founding of Harvard College in 1636, the Charles has seen an impressive educational establishment develop along its shores. Forty-nine degree-granting institutions are located in the watershed, forty-one of them including M.I.T., Radcliffe College, Boston University, etc., clustered in the immediate Lower Charles. The fine and practical arts thrive in the grand tradition of Boston as "The Hub of the Universe".

The Charles River Watershed has become geographically and economically part of the largest employment and population cluster in New England -- the northern terminus of the Atlantic megalopolis stretching between Washington and Boston in which one out of every five Americans lives.

2. The Present

Urbanization has brought its rewards. The Charles area encompasses the principal governmental, commercial, industrial, educational, medical, financial, and cultural institutions of New England. Indeed, as Figure 3 indicates, it is possible to distinguish three separate subregions by their economic and demographic characteristics. The limits of these subregions are coterminous with political boundaries and so differ slightly from hydrologic subdivisions.

The three Charles River economic sub-regions contain all or substantial parts of five cities and twenty-three towns with a total 1970 population of 1,383,766. When population is distributed by sub-region, the Lower Charles clearly predominates; respectively, about seven and eleven times the number of persons living in the Middle and Upper Watershed.

Table 1

CHARLES RIVER WATERSHED POPULATION

Subregion	1950	1960	1970
Upper	54,700	68,981	102,473
Middle	91,444	133,444	158,466
Lower	1,293,176	1,196,949	1,122,827
Total	1,439,320	1,399,374	1,383,766

Source: U. S. Bureau of the Census

The Lower Charles sub-region includes part of the Boston Standard Metropolitan Statistical Area, the eighth largest in the country. The cultural assets, universities, historic structures, and museum and library treasures found in the area are of national and international importance. Today, about one-third of the watershed region is irrevocably urban.

As a whole, out-migration accounts for the 3.8% loss registered between 1950 and 1970. But, again, the intensely urbanized Lower Charles accounts for the effect. Its five cities and four towns have declined by some 170,500 in two decades, or about 13.2%. In sharp contrast are the steep growth curves of the Middle and Upper Charles. The nine towns in the central sub-region gained more than 67,000 in population, an increase of 73.3% over 1950 totals. Higher still are the figures for the towns in the Upper sub-region; a 90.8% increase over post-war levels.

Expressed in terms of density, the 1970 population concentration in the Lower Charles was 9,295 persons per square mile -- equal to the maximum county densities of other nodal areas in the megalopolitan corridor.[2] It must be remembered, of course, that as the site of the earliest permanent settlement along any Eastern river, the banks of the Charles have been urbanized longer than "new" areas like Philadelphia and Washington to the south. Landfilling operations to accommodate influxes of population at Boston began as early as 1643 and climaxed in filling of the Back Bay area impounded by the Roxbury Mill Dam.[3] Upstream, the Middle Charles assumes a distinctly residential character on the order of 1,275 persons per square mile housed in single-family detached wooden dwellings. The Upper sub-region with an average of only 635 persons per square mile is still largely rural to semi-agricultural with scattered industrial complexes and few intensively developed population centers. See Figure 4.

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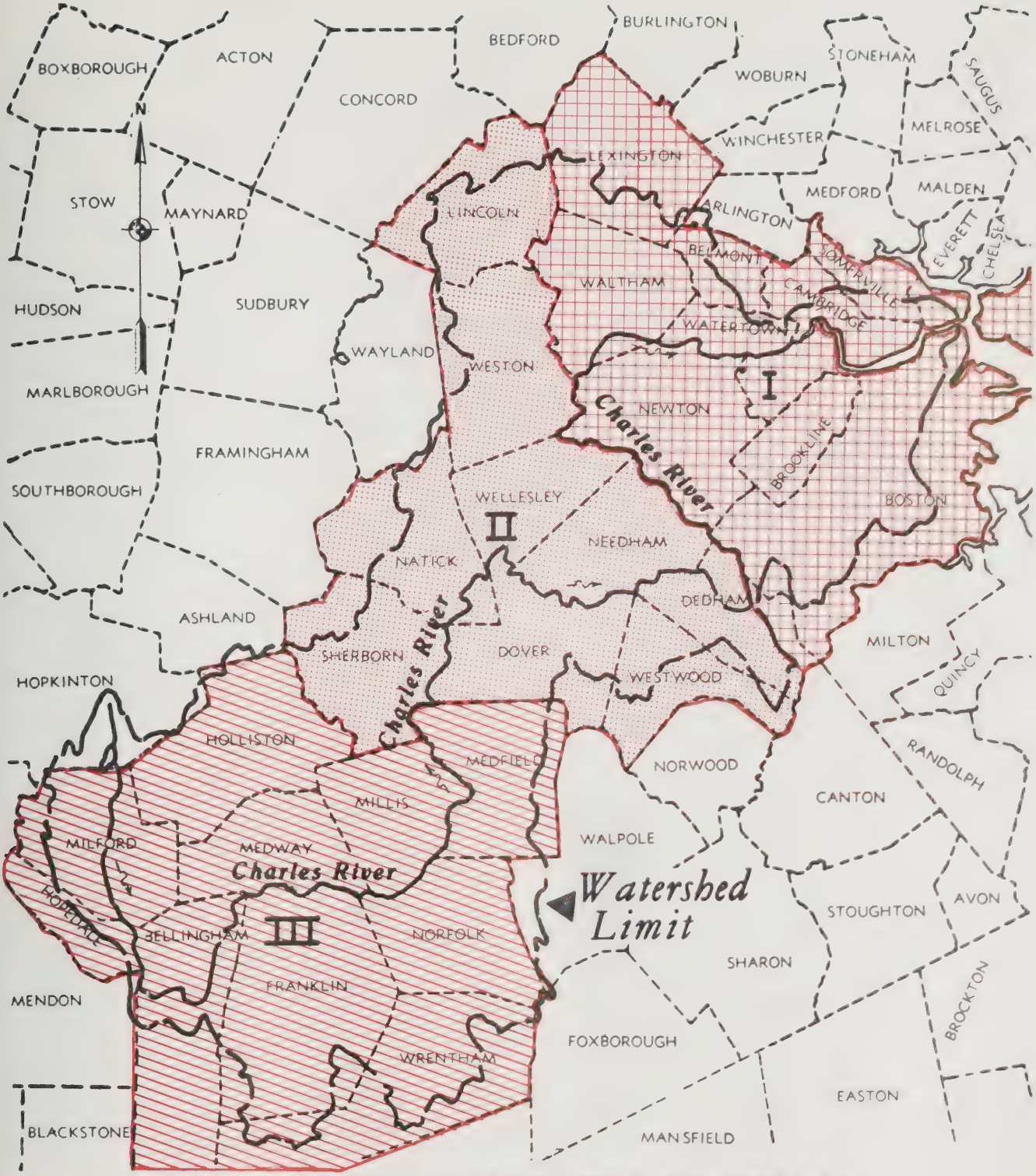
2 Special notice is due the effects of large population loadings related to the strongly academic character of the area. Overall, the forty-nine degree-granting educational institutions located in the Charles watershed enrolled a total of more than 118,000 full time students in the fall of 1966; two-thirds or more of this number from residences outside the watershed. According to New England Board of Higher Education accounts, this was more than one-third of all New England enrollments and better than three-fifths of all Massachusetts enrollments (195,654) that year. In terms of demands on water resources, this academic community is equivalent to a "second city" of more than 70,000.

3 See Walter Muir's Boston: A Topographical History, Harvard University Press, 1968, for a detailed treatment of the correlation between fill sites and socio-economic growth patterns.



CHARLES RIVER WATERSHED

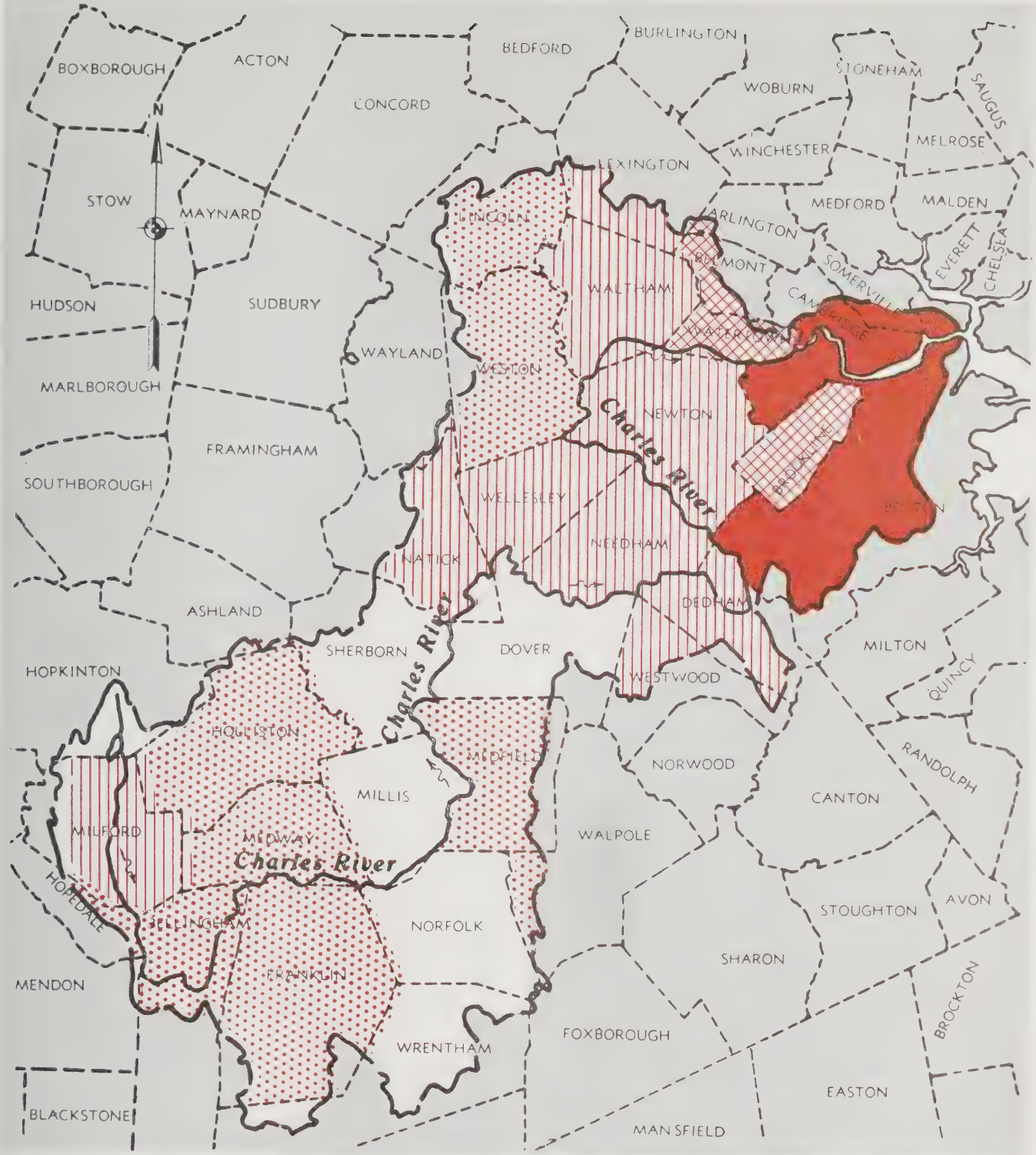
ECONOMIC SUB-REGIONS

LOWER CHARLES

MID-CHARLES

UPPER CHARLES

FIGURE 3



CHARLES RIVER WATERSHED

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

0 5

SCALE IN MILES

1970 AVERAGED RESIDENTIAL DENSITIES

0 to 500 | 500 to 1,000 | 1,000 to 5,000 | 5,000 to 10,000 | over 10,000

(Approx. persons per gross square mile)

FIGURE 4

Table 2

WATERSHED AREA BY COMMUNITY

	Total Area (sq. mi.)	Watershed Portion (sq. mi.)	Percent in Watershed (% of total)
1. Ashland*	12.96	0.56	0.04
2. Arlington*	5.58	0.35	0.06
3. Bellingham	18.86	7.93	42.1
4. Belmont	4.66	1.87	40.2
5. Boston	45.40	25.97	57.2
6. Brookline	6.82	6.82	100.
7. Cambridge	7.14	4.61	62.2
8. Dedham	10.79	7.21	66.9
9. Dover	15.31	13.11	85.6
10. Foxboro*	20.80	0.02	0.001
11. Franklin	27.00	24.50	90.7
12. Holliston	19.10	19.02	99.7
13. Hopedale	5.27	0.99	18.8
14. Hopkinton*	27.92	2.86	10.2
15. Lexington	16.63	4.91	29.5
16. Lincoln	14.92	9.14	61.3
17. Medfield	14.52	11.36	78.2
18. Medway	11.66	11.66	100.
19. Mendon*	17.94	0.29	0.02
20. Milford	14.99	12.93	86.4
21. Millis	12.26	12.26	100.
22. Natick	15.99	8.83	52.2
23. Needham	12.75	12.75	100.
24. Newton	18.33	18.33	100.
25. Norfolk	15.35	15.31	99.8
26. Sherborn	15.39	12.84	83.5
27. Somerville	4.12	1.40	34.0
28. Walpole*	21.09	2.06	9.8
29. Waltham	13.52	13.52	100.
30. Watertown	4.17	3.60	86.3
31. Wayland*	15.88	0.42	0.03
32. Wellesley	10.51	10.51	100.
33. Weston	17.36	15.00	91.0
34. Westwood	11.24	3.82	34.3
35. Wrentham	22.68	9.83	43.3
Total - Sq. Mi.	528.91	307.39	
Total - Acres	(338,8502.4)	(196,729.6)	

Source: Mass. Department of Commerce

City names are underscored.

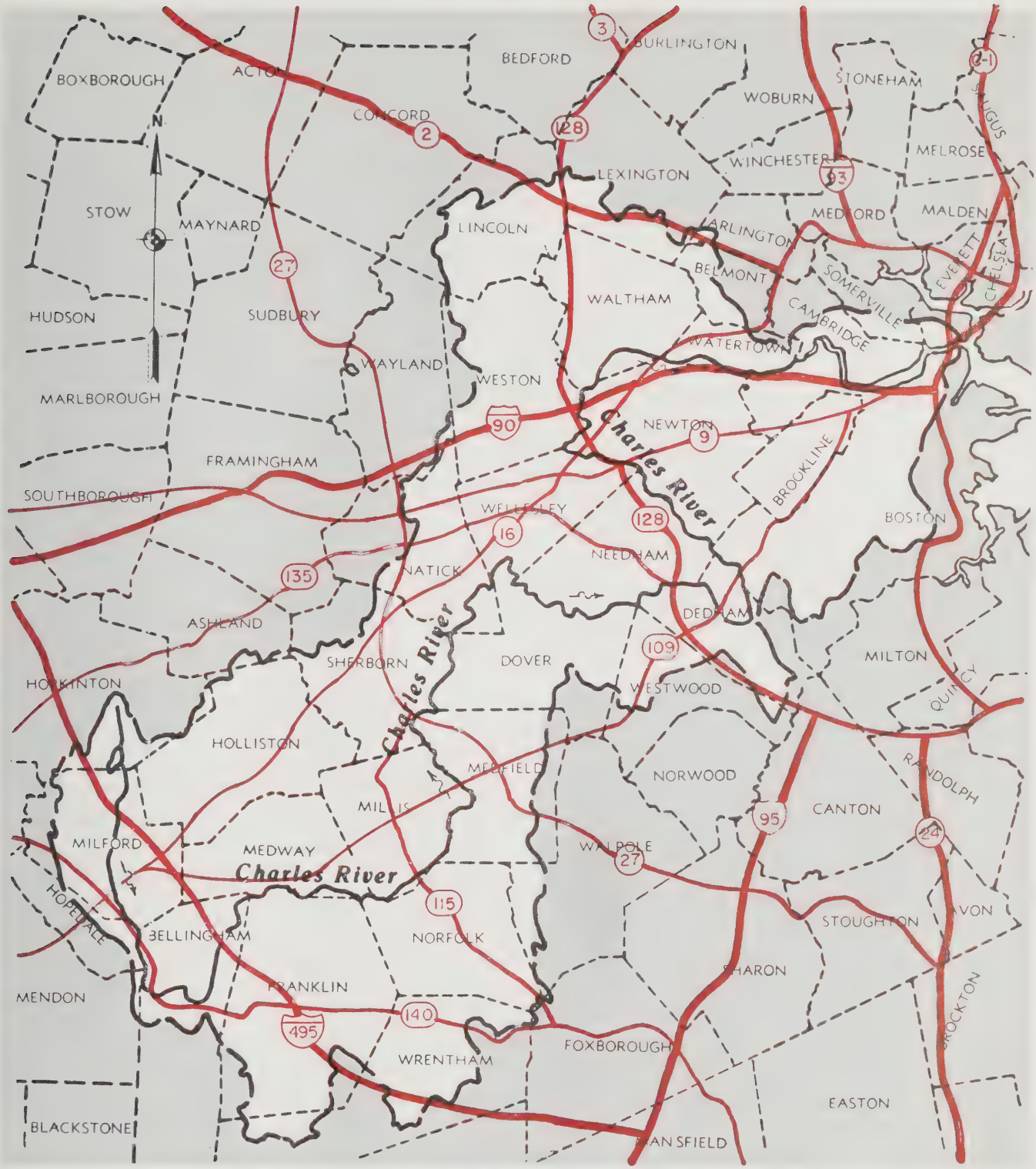
*Not included in Economic Sub-region data.

3. Future Trends

Traditionally, inmigration into the watershed has centered at the lower end, Boston's commercial and industrial nucleus attracting the lion's share of mobile population. Now, however, discernible trends shifting the watershed's center of gravity upstream are emerging. On the one hand, Boston suffers from the same exodus phenomenon troubling most older urban centers nationwide. On the other, the immediate downtown area's loss is largely the Middle Charles' gain. It seems safe to conclude that the substantial increases in density experienced in the pinched portion of the watershed hourglass over the last two decades will continue as major highway arteries like I-90 (the Massachusetts Turnpike) and Route I-495 make residential life outside the older suburban ring more accessible.[4] See Figure 5.

In 1940, over half of the population of the Charles River watershed was concentrated in the Lower Charles sub-region. The rest of the area was rural. But the completion of two limited access expressways in the mid-1950's brought about a dramatic change in the watershed density pattern. Industry and commerce moved quickly into the Lower sub-region to take advantage of the locational convenience. Housing for the employees of the newcomers followed. Public rail and transit transportation were available to only a limited portion of the watershed

4 The transportation network servicing the Greater Boston Metropolitan area is well-developed, though some of the older modes suffer from undercapitalization. The municipalities of the watershed are within easy commuting and trucking distance of air, bus and port and rail terminals at Boston. Public ground transport is provided by the Massachusetts Bay Transportation Authority (MBTA) via subway and surface buses. Domestic and international facilities at Logan Airport bring increasing volumes of passenger and freight traffic into the area, though air freight growth has been at the expense of the seaport. The past half-century has seen little improvement in Boston Harbor and the current trend of redevelopment along the shoreline is toward residential rather than commercial uses. Rail transit is important principally for local commutation and freight service, though recent attention to the AMTRAK system may revitalize long-distance passenger travel.



CHARLES RIVER WATERSHED

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

FIGURE NO. 5

through the 1940's and early 1950's. When rail stations and transit stops were constructed to serve the new expressways, another dimension was added to the transport network so popular with both local commuters and long distance travelers to the south and west. The effects of all these improvements in the transportation system are to be seen in the sharp increases of density in the Upper and Middle watershed between 1960 and 1970 (Table 4, page 28).

Early development was along the arc of Route 128 itself. As this tier of towns filled, growth began in the adjoining areas to the south and west. The pattern of development was more random than before, but generally it followed three regional secondary roads, Routes 135, 16, and 109, which radiate out from Route 128 to the west and south. This gradual expansion trend was accelerated in the late 1960's with the construction of Interstate Route I-495, a limited access belt highway which roughly parallels Route 128 about 16 miles farther out from Boston. Even before the highway was completed in 1970, the Route 128 story was being re-enacted and the communities in the headwaters of the Charles were the fastest growing areas in the watershed. And the trend continues.

Analysis of population trends in the Upper Charles bulb of the watershed show that what were previously rural and semi-rural towns are becoming more noticeably suburban. And there's the rub. As development pressures build up in the upstream reaches of the Charles, natural storage areas responsible for that healthy balancing effect on river flow discussed above are dwindling. More and more filling of wetlands which have only recently become valuable in the commercial sense reduces the quality of the local environment and, more specifically, increases the flood damage potential in riparian areas throughout the Charles' drainage area. As urbanization spreads and pavements and drainage systems replace vegetated areas, storm run-offs are much faster and the saturation capability of the land is exceeded.[5] Hence the novel Corps of Engineers flood control project articulated below. But before exploring the recommended plan of wetlands protection in detail, a brief survey of principal watershed needs and problems is appropriate.

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5 See Appendix D, Hydrology and Hydraulics for an exhaustive treatment of alterations in Basin run-off characteristics.

PART III: CHARLES WATERSHED PROBLEMS

As many other regions of the United States have discovered through sad experience, urban development is a two-edged sword. It does bring with it corporate growth and increased building activity that stimulates first- and lower-order economic responses. However, unless wisely channeled and conditioned, it also brings population glut and an ugly monotony that oppresses the human spirit and ruins the natural environment. Until recently, Charles residents have been the willing victims of "progress". Save for a few persistent voices that prophesied unattractive consequences if rapacious development continued, there was little general awareness or concern for the health of the ecological community. Today, the tantalizing lure of new housing and industrial development is seen in clearer perspective as an ever-widening sector of the citizens begins to question the long-range costs of short-term profit.

A. WATER QUALITY

Improvement in the water quality of the Charles River and its tributaries by modification and enlargement of waste collection systems and waste treatment facilities is an immediate and continuing need throughout the watershed.

The Charles River receives pollutional loads from two principal sources: upstream industries and municipalities, and storm and combined sewage overflows dumped directly into the basin pool. During periods of precipitation, older communities discharge sanitary sewage effluent through overflow structures. During the 19th century, it was an economical and, therefore, a common practice to provide one sewer line to carry both sanitary sewage and rainfall run-off. To prevent undue stress on the combined sewer line during an abnormal downpour, a series of reliefs or overflow structures was built to avoid sewage back-up into cellars, catchbasins or streets. Once this overflow discharged to a Charles estuary, flushed out twice a day by tidal action. But since the present Charles River Dam was built, such tidal action has ceased and untreated or inadequately treated wastes are confined in the basin.

In 1968, approximately 3,100 pounds of BOD[1] were discharged daily to the upper Charles watershed from known sources. The raw waste load before treatment was approximately 8,300 pounds per day. This, combined with the stormwater flows of the middle and lower Charles seriously degrade the quality of the main stem. In 1971, major sections of the Charles River still did not meet the criteria established by

[1] Biochemical oxygen demand (BOD) is a measure of wastewater pollutional strength based on the amount of oxygen required by bacteria to oxidize organic material.

the Commonwealth for dissolved oxygen, coliform bacteria and nutrients such as phosphate and ammonia.[2] Until State standards as a minimum goal are achieved, the full potential of the Charles will go unrealized.

[2] Stream classifications indicated in Figure 6 and Table 3 are defined as follows. See Appendix E, Water Quality, for full descriptions.

Class A -- Waters designated for use as public water supplies in accordance with the General Laws. Character uniformly excellent.

Class B -- Suitable for bathing and recreational purposes including water contact sports. Acceptable for public water supply with appropriate treatment. Suitable for agricultural, and certain industrial cooling and process uses, excellent fish and wildlife habitat; excellent aesthetic value.

Class C -- Suitable for recreational boating; habitat for wildlife and common food and game fishes indigenous to the region; certain industrial cooling and process uses; under some conditions acceptable for public water supply with appropriate treatment. Suitable for irrigation of crops used for consumption after cooking. Good aesthetic value.

Class D -- Suitable for aesthetic enjoyment, power, navigation, and certain industrial cooling and process uses. Class D waters will be assigned only where a higher water use class cannot be attained after all appropriate waste treatment methods are utilized.

Class SC -- Suitable for aesthetic enjoyment; for recreational boating; habitat for wildlife and common food and game fishes indigenous to the region; industrial cooling and process uses.

Table 3

CHARLES RIVER WATERSHED CLASSIFICATION

Boundary	River Miles	Present Use	Anticipated Future Use	Present Condition	Classification
The Charles River from its source to Dilla Street, Milford	80.1-76.5	Water supply	Water supply	A	A
The Charles River from Dilla Street, Milford to Main Street, Milford	76.5-75.2	Fishing Fish & wildlife propagation	Same	D	B
The Charles River from Main Street, Milford to Bridge Street, Dover	75.2-44.7	Recreational boating Fish & wildlife propagation Fishing Assimilation	Same	D & C	C
The Charles River from Bridge Street, Dover to Watertown Dam, Watertown	44.7- 9.8	Recreational boating Fish & wildlife propagation Fishing Assimilation	Same and bath bathing	D & C	B
The Charles River from Watertown Dam, Watertown to the Charles River Basin Dam in Boston	9.8- 1.2	Recreational boating Fish & wildlife propagation Fishing Assimilation	Same	D & C	C
Farm Pond, Sherborn	--	Recreation	Recreation	B	B
All other streams in the Charles River Watershed unless denoted above	--	--	--	-	B

Source: Commonwealth of Massachusetts, Water Resources Commission, Division of Water Pollution Control.

COMMONWEALTH OF MASSACHUSETTS
WATER RESOURCES COMMISSION

CHARLES RIVER BASIN

CLASSIFICATION

WATER USE CLASSES - (A) (B) (C) (D) (SB)

— CHANGE CLASSIFICATION

FIGURE 6

FORM WPC28 IM-2-67-944469

B. WATER SUPPLY

Water needs for most of the lower Charles population are now met by the Metropolitan District Commission from out-of-watershed sources in the Merrimack and Connecticut River Basins. Existing statutes provide that a municipality, any part of which is within 10 miles of the State House on Beacon Hill, Boston, may become a member of the MDC's Metropolitan Water District upon application. The statutes also provide that a municipality, any part of which is within 15 miles of the State House, and which the MDC could reasonably supply with water may, upon application, be admitted to the system. The City of Cambridge, for example, has a mixed supply; part from Stony Brook and Hobbs Brook Reservoirs and the balance made up by MDC water. By contrast, local water needs in the upper Charles are presently met almost wholly from groundwater and surface sources within the watershed. See Figure 7.

However, the prospects for meeting future supply requirements, which grow exponentially as watershed densities increase, are uncertain at best. An investigation of Charles area groundwater sources being carried out by the U. S. Geological Survey, Department of the Interior, is not yet complete, but there are data collected by USGS for the eastern part of Massachusetts and Rhode Island generally. Part of the Corps' NEWS (Northeastern Water Supply) Study, they indicate that known groundwater reserves are totally insufficient to meet the escalating demand in the Metropolitan Area Planning Council (Boston) region. Further, seismic surveys made for the Massachusetts Water Resources Commission between the late 1930's and 1966 substantiate that result. Of course it is still possible that additional field boring work and skilled interpretation of geologic mapping will reveal new water-bearing strata, but, for the present, the outlook is pessimistic.

The study performed for the Metropolitan Area Planning Council by the architect-engineering firm of Camp, Dresser & McKee concluded that of the 17 municipalities in the middle and upper Charles, none can meet its 1990 demands exclusively with present resources. However, with the optimal development of new local supplies, Wayland, Wellesley, Walpole, Franklin, and Milford could meet their 1990 forecasted need. Beyond 1990 the picture growns dimmer still, and the expansion of the MDC system yield appears inescapable if the growth of metropolitan demand for water continues unchecked.

C. OPEN SPACE AND RECREATION

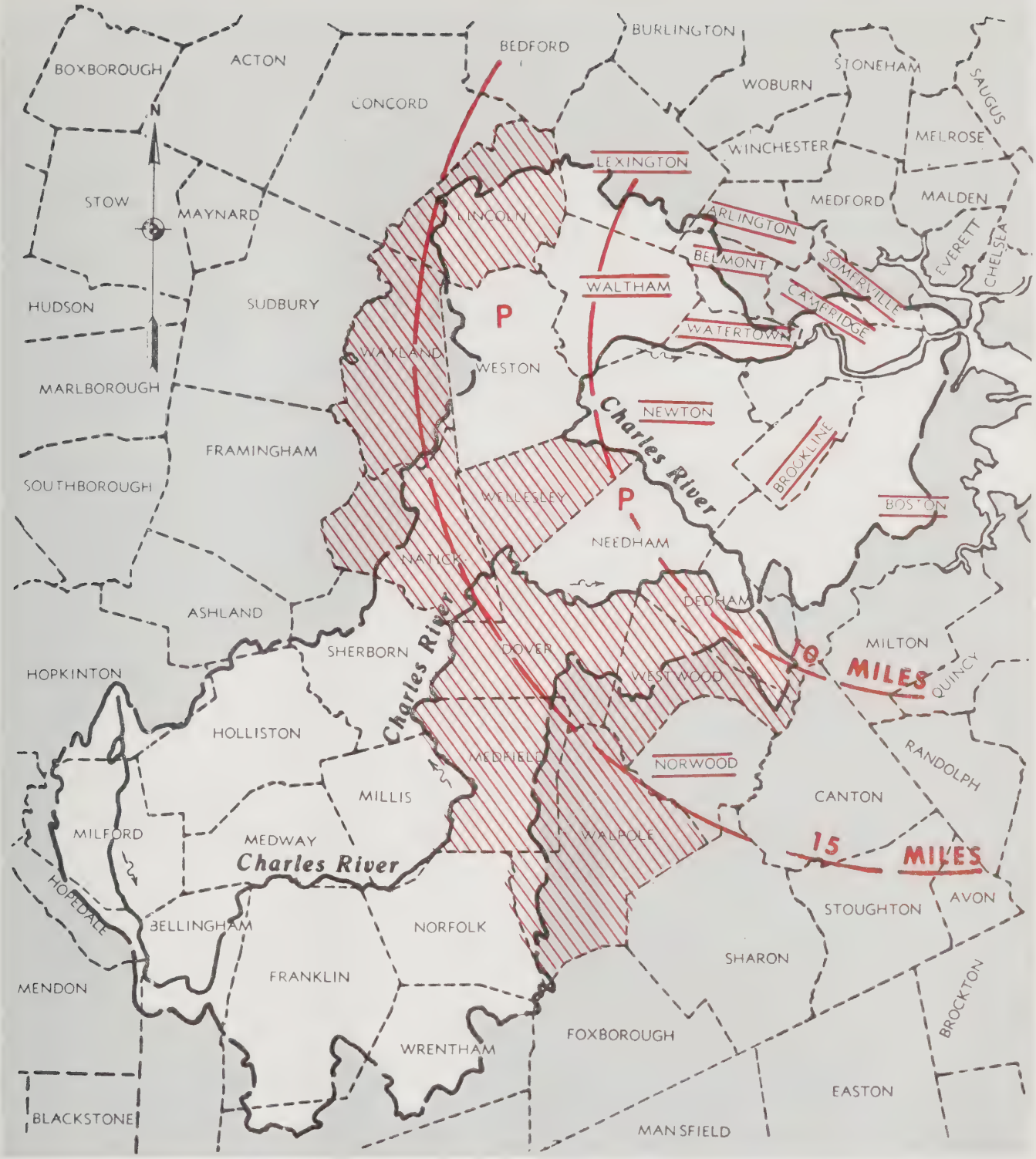
Also related to the larger problem of urban sprawl is the rapid depletion and degradation of valuable open space in the upstream portions of the Charles. A careful study of the main stem above Watertown reveals an alarming trend toward encroachment on the now empty flood plain. Again, increasing population pressures are the catalyst for new development as Table 4 suggests.

Table 4

UPPER AND MIDDLE CHARLES (Reaches 1-4)
(Densities Per Square Mile)

1940	347.0	
1950	442.9	
1960	586.5	
1970	760.1	
1980	1059.0	projections
2000	1984.0	
2020	2198.0	

As an improving transportation network links this area to the cities of Boston, Worcester, and Providence, its developable land will fill up until the upper Charles becomes surfeited and excess population gravitates elsewhere. Yet the supply of open land in the Boston Metropolitan area is already low by any measure and the outdoor recreation demand is greater than ever. Clearly, open space now in public or semi-public lands must be preserved so. Moreover, additional land - particularly those extensive marsh areas in the upper reaches of the Charles - must be protected to provide canoeing, fishing, and passive recreational resources for the immediate future. The potential for intelligent utilization of natural areas is enormous; long stretches of meandering river, extensive areas of wooded and marshy wildlife habitats, numerous archeologic sites dating from the pre-Columbian era, etc.



CHARLES RIVER WATERSHED

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

0 5

SCALE IN MILES

METROPOLITAN DISTRICT COMMISSION WATER SUPPLY

TOWN PRESENTLY SUPPLIED BY M.D.C.

P PARTIALLY SUPPLIED BY M.D.C.

ELIGIBLE TO APPLY FOR M.D.C. WATER

FIGURE NO. 7

Neither should man-made ponds be overlooked; recreation, conservation, and beautification opportunities exist at each of the 20 dams now impounding the Charles. Adequate fishways together with dramatic improvements in water quality could bring the river to its full potential as a habitat for anadromous and resident species.[3] Better locking facilities for commercial and pleasure craft so long needed between the lower Charles and Boston Harbor will be provided by the multiple-purpose dam at Warren Avenue proposed in the Interim Report for Flood Control and Navigation. In addition, boating facilities are sorely needed upstream where population clusters are forming most rapidly.

Most vital to the future welfare of the region and the nation is the guarantee of protection for open areas. With timely action, those fragile portions of the natural environment still left undisturbed can be removed from the private sector where they will fall prey to development and become instead a legacy passed by this generation to all those that follow.

[3] The Metropolitan District Commission plans to install adequate fish ladders up to and including the South Natick Dam and is now constructing a fish ladder at the Watertown Dam. Funds to complete the program are being sought in the current session of the Massachusetts Great and General Court.

D. FLOOD CONTROL AND DRAINAGE

Not the least pressing on the roster of difficult problems confronting the Charles watershed is a steadily more ominous flood damage threat. The now-authorized new dam at Warren Avenue, just above the river's mouth will eliminate the better part of existing flood hazards in the immediate Charles Basin; but equally serious consideration is due the rest of the watershed where the flood problem is exacerbated by continuing development. As discussed above, all the elements of intensive future watershed development are now present and a growth rate set at slightly more than 1 percent annually over the next 50 years is not unduly optimistic.[4]

Following the logic outlined in previous sections, there is no reason to think that communities will recognize their individual contributions to the over-all flooding situation any more than they have in the past. Without external coordination, municipalities will pursue independent development plans, nibbling away at marsh storage areas piecemeal until the aggregate effect of their expansion is felt as a major flood disaster. By filling and paving over previously natural areas, they will have simultaneously increased storm run-off and decreased the ability of the land to accommodate it safely.

Generally, because of the large amount of moderating natural storage in the watershed, it has been rainfall amounts rather than precipitation intensity that have determined the magnitude of resulting floods in the Charles. Given the urbanization pending in the near future, however, floods will be more frequent and greater in magnitude. Minor storms in 1980 will produce the same flows associated with moderate storms in 1970 Thus, the major storms of 1980 and 2000 will have much greater flood potential than similar storms under today's conditions.

For example, a recurrence of the record flood elevations of March, 1968 would cause losses estimated at $400,000 between Bemis Dam in Watertown and South Natick; about half the loss would be residential and the balance would be sustained by commercial and light industrial establishments. A stage 1 foot higher would increase the total loss to $1 million. At a stage of plus 2 feet the loss would escalate to $2 million, and at a stage 4 feet higher than 1968, would exceed $6 million.

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[4] See appendix B, Economics and Appendix H, Flood Management Plan Formulation for a full discussion of economic trends in the Charles River watershed.

These are estimated direct losses. They do not reflect either the drastic depreciation in property values for residential properties subject to frequent flooding or the probable lowering of rental values in the industrial and office parks along the Charles.

Residential properties vary from units in the $60,000 to $80,000 class in Waban to apartment buildings, a small trailer park and $20,000 to $30,000 single homes in Dedham. The bulk of the commercial properties affected are located in a large shopping center on the Boston-Dedham line. Other concentrations occur in Newton Lower Falls, at an office park on the Wellesley-Newton line, and at scattered locations in Dedham. Industrial properties subject to flooding, especially at plus stages, are located in the Needham-Newton Industrial Center, a new industrial park in Newton and at scattered locations between Newton Upper Falls and Dedham. In addition, some older industrial properties lying along the river banks in Waltham are equally vulnerable.

Serious as this threat is, the situation worsens when the time frame of loss calculation is extended into the future. Recent trends in flood loss potential indicate that in developed or partly developed areas losses tend to increase with time. This is especially true with industrial properties where the effort to remain competitive means increasingly sophisticated plants and the tendency to expand to occupy every available piece of land. All this is related to the increasing wealth in the area expressed as personal income. In the Charles River, personal income is projected to increase approximately 6.5 times in constant 1958 dollars over the next 50 years. Current flood losses are projected to increase at a rate equal to 50 percent of the increase in personal income. The table below shows recurring losses at various flood stages in three future decennial years.

Table 5

RECURRING LOSSES AT VARIOUS FLOOD STAGES
1970 - 2000
($1000s at 1970 Price Level)

Year/Stage	1970	1980	1990	2000
1968	400	500	620	820
1968+1	1,000	1,230	1,550	2,040
1968+2	2,000	2,450	3,100	4,070
1968+3	3,500	4,300	5,430	7,120
1968+4	6,000	7,350	9,310	12,210

When these recurring losses are combined with stage-frequency data, the product is damage frequency measured as annual loss. For example, natural annual losses in the reach between Charles River Village and Bemis Dam in Watertown amount to $158,000 under 1971 conditions. Still more alarming, however, are the annual loss data generated from stage-loss and stage-frequency figures at conditions of 10, 20, 30, and 40 percent loss of natural valley storage. For the same stretch of river, expected damages rise disastrously as the buffering action of natural marsh areas on peak flows is eliminated. And, unfortunately, that eventuality is all too probable.

Table 6

ANNUAL FLOOD LOSSES AS A FUNCTION
WETLANDS LOSS

Condition	Annual Loss
Current - 1971	$ 158,000
With 10% loss of Storage	229,000
With 20% loss of Storage	414,000
With 30% loss of Storage	641,000
With 40% loss of Storage	957,000

In a study made by the Massachusetts Department of Natural Resources in 1967 it was determined that for the State as a whole, wetlands were being lost at a rate of 1 percent annually. Considering the present and projected pressures for land in the Upper Charles watershed, it is likely that the rate of wetland loss is more than double the State-wide average. At this rate, over 50 percent of the wetlands will be gone in 20 years. Loss of these wetlands will mean a 30 percent loss of valley storage by 1990. This puts the calculated annual losses of $641,000 under 1971 economic conditions in 1990. As previously discussed, losses are projected to increase over time at a rate which is 50 percent of the projected increase in personal income in the region. The increase in losses by 1990 brought back to present values using an interest rate of 5-3/8 percent amounts to an average annual equivalent increase of 34 percent.

E. CONCLUSIONS

The prospective doubling of flood loss potential in the thirty years between 1970 to 2000 combined with the density projections for the same period make some form of development controls imperative. To mitigate the effects of urbanization, natural wetlands and certain key waterway openings at the downstream end of wetlands must be maintained in their present condition.[5]

While such controls could take the form of restrictive zoning by local, i.e., individual community authorities, the need for overall coordination would call for extraordinary cooperation among municipalities. Given their record to date, such efforts are difficult to envision. A more effective approach would be for the State or Federal government to handle the out-right purchase of critical wetlands. In order to maintain the flood safety of the Charles River Watershed, immediate public acquisition of existing natural storage areas in fee or through permanent easements should have first priority.

The existing wetland storage areas are, in effect, a natural reservoir which, in its present state, brings about a marked reduction in flood stages. Protection of this reservoir is necessary, so that future flooding will be minimized. The alternatives are not appealing. Without strong controls, wetland storage will be lost to urbanization and the existing natural reservoir will be reduced in size. The resulting higher flood stages will cause severe damage, unless substantial structural measures are implemented. Implementation of substantial structural measures, for example the considered 55,000 acre-foot reservoir or the extensive dikes and walls, would be not only unreasonably expensive but extremely disruptive.

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5 Adding to the effectiveness of wetland areas as flood safety mechanisms are undersized culverts and bridge openings which, in effect, form flood water retarding structures on some of the watershed's roads.

PART IV: THE CHARLES COORDINATED WATERSHED PLAN

The general objective of this study was the formulation of a watershed development plan which could serve as a guide for the best combined use of the water and related land resources of the Charles River. Within that broad framework, specific emphasis was given flood control and streamflow management requirements. The resulting plan is presented here, a multiple-purpose project that satisfies the articulated needs of a range of watershed interests and, at the same time, effectively eliminates the growing probability of major flooding.

The Coordinating Committee has concluded after exhaustive review of several technical alternatives that the optimal solution is non-structural.[1] Its recommendation is that the Corps of Engineers in consort with the Commonwealth of Massachusetts acquire the valley storage areas of the Middle and Upper Charles Watershed and maintain their natural state in perpetuity. The inputs to this unique proposal have been diverse and well-balanced. Water supply considerations are based largely on a Metropolitan Area Planning Council report and the Corps' own Northeastern Water Supply Study. Information on fish and terrestrial wildlife came in draft reports prepared by the U. S. Fish and Wildlife Service and through exhaustive technical discussions with the relevant state agencies. Navigation aspects are covered in the Interim Flood Control Report of 1968 covering the Lower Charles and by Interim Memo #5 of the present study.[2] Most importantly, though, the proposal reflects the views of Charles residents themselves. Through the work of the Citizens' Advisory Committee, it has been shaped to their satisfaction as being fully consonant with the best long-range interests of their watershed.

The following sections outlined the non-flood control elements of the plan as they address the problems discussed in Part III and interrelate with the flood control questions treated in Part B.

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1 The following appendices provide detailed analysis of the Coordinating Committee plan by water resource elements: Appendix E, Water Quality; Appendix F, Upper Charles River Tributaries and Impoundments; Appendix G, Outdoor Recreation and Environmental Conservation; and Appendix H, Flood Management Plan Formulation.

2 Appendix A, Conduct of Study, contains a complete listing of the Interim Memos prepared during the course of the Corps' investigation.

Table 7 presents the costs for an early action plan serving the entire watershed in the resource areas discussed above.

TABLE 7

COORDINATED WATERSHED PLAN
EARLY ACTION EXPENDITURES

WATER QUALITY	
Construction of Basin Elevation Control Structure-Sewer Modification by Local Interests	$ 7,400,000
Charles River Basin Restoration Programs	7,000,000
Sewage Treatment Plant providing primary treatment, secondary treatment, coagulation, sedimentation, filtration, carbon absorption, post aeration and Chlorination	15,000,000*
WATER SUPPLY	
Four subgroups of Middle and Upper Charles	29,000,000
OPEN SPACE AND RECREATION	
Acquisition and protection of 13,500 acres for Corridor Plan	27,500,000
Acquisition of 1,070 acres for conservation and preservation of Open Space Areas	Not estimated
Acquisition of 8,000 acres for five Potential Reservoir Sites	Not estimated
Bikeways	Minimal

*This figure reflects the cost of additional sewage treatment facilities in the upper reaches of the Charles.

TABLE 7
(Cont)

NAVIGATION	
Construction of Basin Elevation Control Structure	
Navigation Allocation	$ 8,100,000
Canoe Launch Sites	Minimal
FISH AND WILDLIFE	
Construction of fish ladders from mouth of river to South Natick Dam	870,000
FLOOD CONTROL	
Construction of Basin Elevation Control Structure	
Flood Control Allocation	20,900,000
Transportation Allocation	1,200,000
Acquisition of 8,500 acres of natural valley storage	7,340,000
TOTAL WATERSHED EXPENDITURE	$124,310,000

A. RELATED RESOURCE CONSIDERATIONS

1. Water Quality

The Coordinating Committee finds that ample opportunities exist for all levels of government as well as the private sector to improve water quality in the Charles.

Along the River from the South Natick Dam to the Charles River Dam, the Metropolitan District Commission has been carrying out an ambitious pollution abatement program by constructing adequate interceptor and relief sewers to reduce sewage overflows to the river. In the Lower Charles, in addition to the relief sewers constructed on both sides of the river, the M.D.C.'s stormwater chlorination and detention station located near the Boston University Bridge serves the combined sewer systems of the North Charles, South Charles and Brookline. The total cost of this facility was $4.7 million, $1.0 million contributed by a demonstration grant from the former Federal Water Quality Administration, Department of the Interior, now the Environmental Protection Agency.

As part of its high-priority effort to reduce or eliminate other frequent overflows, the M.D.C. is in the design stage of a fully funded $13 million program for the Lower Charles. It will provide conduits in Boston and Cambridge between the present Charles River Dam and the proposed dam at Warren Avenue to intercept all overflows and both the Boston and Cambridge Marginal Conduits. A pumping station and a chlorination/detention center are included in the project to discharge the clarified and disinfected effluent to tidewater below the new dam. This pumping facility will isolate the Marginal Conduits from tidal influence and thereby further relieve pollution from overflows in the Lower Basin as far upriver as the Back Bay Fens.

Another prime mover in the effort to restore the Charles is the Commonwealth's Division of Water Pollution Control. Part of the Department of Natural Resources, the Division has established water quality standards for the river and now administers the implementation

program under which treatment works are to be built.[3] However, as of this writing, the river is still seriously degraded by waste discharges and it has become clear that advanced unit processes beyond secondary (biological) treatment will be necessary to effect adequate renovation. Without flow augmentation to meet the desired dissolved oxygen level, for example, between 94% and 98% BOD removal will be essential by 1980. Indeed, with phosphate removal by chemical means and postaeration, the effluent from treatment works will likely be superior in quality to present river water.

Such treatment procedures are admittedly expensive, but given increasing volumes of influent they are inescapable. As noted in Appendix E, Water Quality, the projected waste flows from the Upper Charles River communities will be 11.7 cfs, 26.4 cfs, and 53.2 cfs by the years 1980, 2000, and 2020 respectively. Measured at the Charles River Village gage, which is downstream of all projected waste discharges, the present seven-day low river flow is only 12 cfs. Therefore, during future low flow periods, most of the river's flow will be made up of waste discharges and the Charles' utility as more than a sewer will depend on the thoroughness of wastewater treatment techniques.

The following recommendations are included in the Coordinating Committee's findings:

- The communities in the Upper Charles River watershed should consider forming a regional sewerage district, particularly since future treatment plants, whether they serve an individual community or a larger area, will be technically sophisticated and require highly trained personnel. In that respect, a single regional authority offers distinct management advantages. The recruitment and supervision of top rank operations personnel is more

3 The schedule drafted for the Charles watershed calls for the construction of regional waste treatment facilities by 1973. Polluters are notified that they are in violation of quality standards and then put on a compliance timetable which culminates in the construction and operation of wastewater treatment facilities.

efficient and operational and maintenance problems can be corrected more quickly. A greater variety of specialists is on constant call and significant economies are possible with central maintenance facilities and a large spare parts inventory.

- To reduce the adverse effects of urban runoff watershed communities should enact and enforce comprehensive sewer-use ordinances, establish effective sewer inspection and maintenance programs, and implement urban landscaping programs.

- In those communities where pollution from solid waste disposal now occurs, corrective measures should be taken in accord with implementation schedules established by the Commonwealth of Massachusetts.

- State and local highway departments should use a minimum of chemical deicers like salt and institute the proper storage procedures to reduce saline contamination of ground and surface waters.

- Water quality standards should be continuously evaluated and upgraded to reflect changes in the parameters of public expectations, available technology, and financial resources.

- Innovative technologies for treating river water itself should be thoroughly investigated.

The Corps also gave consideration to the possibility of diverting flood flows both within the watershed and from adjacent river basins to be stored and used as low flow augmentation during dry periods. Diversions from outside the Charles were considered at Hopkinton's Bloods Pond and North Pond, but both these proposals were dropped because of high real estate costs. The two other in-basin diversion projects studied were for Bogastow Brook and Beaver Brook. Upon analysis of the flows of the Charles River at Bogastow Brook during periods of low flow, however, it was concluded that the flows in the Bogastow were

not sufficient to allow an appreciable diversion to the Charles River main stem. The diversion of Charles River freshets to Beaver Pond in Bellingham with releases back to the Charles made via Beaver Brook was dropped because of prohibitive real estate costs and conflicting water rights.

Generally, the diversions considered were capable of providing only five to ten cfs during the summer months because of hydraulic or site limitations. Because the benefits accruing from low flow augmentation to improved water quality and fish and wildlife were minor and the small pools created at the impoundments were unsuitable for recreational use, diversions are not part of the recommended project.

2. Water Supply

The Committee recognizes that the less densely populated Middle and Upper Charles communities can meet near future water supply needs through regional development of sources located within the watershed. However, to meet the long-range need beyond the turn of the century, diversion of supply from outside the watershed and reuse of treated effluent must be seriously considered.

The Committee therefore recommends that a regional approach be taken in planning for future water supply needs. As noted previously, most of the Lower watershed is serviced by the Boston Metropolitan District Commission from sources in the Merrimack and Connecticut River Basins, notably Quabbin Reservoir, the largest component in the MDC System. Because of pressing 1990 demands on the MDC system, diversions of Millers River flood flows to Quabbin Reservoir are being considered as part of the Corps' Northeast Water Supply Study. Moreover, the M.D.C.'s planned diversion of Connecticut River water to Quabbin through the Northfield Pumped Storage installation has been authorized and funded by the legislature. These diversions and those from other basins offer a potential source of water supply, not only for present MDC communities but also for those of the Upper Charles watershed should they request admittance to the system.

3. Open Space and Recreation

The Coordinating Committee recommends that to preserve the green and open space as well as to secure public access to it, an outdoor recreation and environmental conservation corridor be established in the Charles River watershed. This conclusion reinforces the independent findings of three Commonwealth agencies actively planning recreation opportunities for the Charles: the Metropolitan Area Planning Council, Metropolitan District Commission, and the Department of Natural Resources.

- Metropolitan Area Planning Council

The most popular forms of summer outdoor recreation are either water-dependent or water-enhanced. With a growing population, with increasing leisure time and disposable income and greater transportation mobility, citizens can be expected to spend more time on outdoor recreation pursuits. The Metropolitan Area Planning Council recommended in its report "The Mystic, Charles and Neponset Rivers".

> "Open space, conservation and recreational development of the Charles should be undertaken immediately at standards commensurate with the scope and design example set by early plans and development of the Basin and its embankments. The River and associated wetlands should be publicly owned or controlled from Boston Harbor to Echo Lake. The River should be planned to provide a focus for use for each of the communities along its banks and for visitors from other areas. These uses should take advantage of and emphasize the natural diversity and contrasts of the Valley and offer a wide range of recreational experiences. Above all, continued concerned support must be given to programs which will rid the River of pollution so that its full recreational potential can be realized. The acquisition or protection of the entire River, banks and wetlands, must have top priority."

- Metropolitan District Commission

As the successor to separate Parks, Sanitary and Water Supply authorities established in the late nineteenth and early twentieth centuries, the M.D.C. exercises comprehensive statutory and regulatory powers over the Charles River area. The Commission owns or controls

nearly all of both banks of the Charles River between the Charles River Dam at Leverett Circle, Boston, and the Watertown Dam above Galen Street, Watertown. In addition, the Commission owns or controls the major portions of both banks of the Charles River between Watertown Dam and South Natick Dam. Its total holdings encompass 39.1 miles or 80.5% of the 48.6 miles of the Charles River shorelines between the Boston Dam and Route 109 Dedham-Boston.

Together the Planning Division, Engineering Division, Parks and Recreation Division, Enforcement Unit, and its Administrative Office have expended hundreds of millions of dollars over the terms of nearly a century to enhance the Charles as a water resource. Responsible not only for the Basin but also for upriver shorelines, the Commission is authorized to acquire and beautify open spaces adjacent to the river for exercise and recreation. Its powers also extend to flood control dredging between Watertown and the South Natick Dam and to the management of other impoundments along the main stem and Mother Brook. In the water quality field, the M.D.C. has undertaken several projects to reduce or eliminate pollutional discharges into the Charles and is empowered to prohibit any injurious sewer connection.

The Recreation Division of the M.D.C. operates all recreational facilities and oversees the development of organized recreation programs. It has under its jurisdiction 21 artificial ice-skating rinks with 7 more in the design process, 16 outdoor swimming pools and 3 indoor swimming pools, 17 salt water beaches, 4 fresh water beaches, 2 golf courses, 21 athletic fields, 40 children's play lots and boating, picnic and band concert facilities.[4] Existing plans in the Charles region call for like facilities which will better serve the recreational needs of a growing population.

- Massachusetts Department of Natural Resources

The D.N.R. report "Outdoor Recreation and Environmental Conservation in the Charles River Watershed" expresses the following goals:

4 Clearly, not all of these MDC properties fall inside the watershed.

1. Protect all of both banks of the Charles River from end to end to establish in perpetuity a linear scenic and recreational waterway and adjoining landways for human enjoyments: Canoeing, fishing, boating, bathing, bicycling, hiking, horseback riding, picnicking, sightseeing, bird-watching and just plain grass-sitting, for examples.

2. To link up in perpetuity wherever feasible all existing public and semi-public lands on or near the Charles River banks. This will protect existing reserved lands and will re-enforce and enlarge the outdoor recreation values of the entire reserved land system in the Charles River Watershed.....

The Coordinating Committee recommends that the outdoor recreation and environmental conservation plan prepared by the Massachusetts Department of Natural Resources be accepted as the definite guide for the development and beneficial use of the water and related land resources of the Charles River watershed.[5] Further, conservation areas of approximately 1000 acres at seven sites designated by the Soil Conservation Service should be preserved as open space. To that end, action should be taken by local Conservation Commissions to excite community interest and apply for self-help funds offered by the Massachusetts Department of Natural Resources.

The Committee also finds that there is need to construct new fish passage facilities and upgrade old ones as a part of maintenance programs at existing dams. The character of the Charles River is dependent on such dams to create pools of substantial width and length. Without them, the river would be narrow and only barely visible during much of the year.

- Recreation

Since the initiation of the Charles River Study, many private persons and local authorities in the watershed have expressed great interest and enthusiasm in canoeing opportunities on the Charles. As a

5 See Appendix G for a full description of the D.N.R. plan for the Basin.

part of their response to that concern, members of the Corps' New England Division floated the Charles by canoe in May 1967. The canoe team located favorable sites for launching and landing canoes and collected other information of value to those who enjoy this relaxing form of river recreation. The potential sites identified are enumerated in Attachment II of Appendix H and shown on Plate 1 at the back of this report. It is hoped that this information will be the basis for an implemented canoeing program in the Charles main stem.

Within the Lower Charles area, opportunities for bikeways abound. The bikeway system offers valuable recreational outlets for an urban population and should become a priority item in local planning efforts. Federal assistance monies can be made available by the Bureau of Outdoor Recreation, Department of the Interior, the Department of Housing and Urban Development Open Space and Beautification Programs and the Urban Renewal Administration for Urban Planning Assistance, as well as the Highway Beautification Act of 1965 administered by the Bureau of Public Roads.

Particularly exciting are recreation potentials related to fish and wildlife productivity. In the short terms communities may supplement water-oriented forms of recreation by creating small ponds or conservation pools at the sites recommended by the survey work of the Soil Conservation Service.[6] More ambitious plans call for the restoration of the anadromous fishery in the Charles main stem. Healthy communities of alewife and American shad will be possible, however, only as improvements in water quality and the construction of modern fish passage facilities become realities.

Development and management of upriver marshes could be the province either of the Massachusetts Department of Natural Resources or the Department of the Interior. The Coordinating Committee recommends that the fish and wildlife plan for water resource development in the Charles River include at least the following:

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6 See Appendix F, Impoundments and Tributary Watersheds, for details of the Soil Conservation Service report. Towns seeking financial assistance for creating conservation areas should make application to the Department of Natural Resources through their Conservation Commissions.

1. Conservation and enhancement of the indigenous warm-water fishery with specific attention to the creation of additional lake-type fisheries.

2. Conservation, enhancement, and creation of trout habitat and trout fishing opportunities.

3. Enhancement of the fishery based upon anadromous fish species.

4. Preservation and enhancement of existing waterfowl habitat with the creation of additional waterfowl habitat needed for breeding, resting, and feeding. Waterfowl hunting opportunities should be explored.

5. Preservation of all existing wildlife resources in connection with water resources development.

B. FLOOD MANAGEMENT CONSIDERATIONS

1. The Lower Charles

The flood problem in the Charles River Basin is principally the result of intense urbanization which shortens normal storm runoff periods. Aggravating the situation is the lack of control over the water level of the Basin in which the runoff collects. Alternative solutions considered to mitigate this problem were upstream reservoir storage diversion and the provision of pumping facilities to afford a reasonably constant level in the Basin at all times. Thought was also given to the use of flood-proofing and zoning measures to decrease future flood damages in the area adjacent to the Basin. However, when it became clear that these latter measures would require vast sums of money and completely disrupt normal city functions, this alternative was abandoned. Since the upstream reservoir scheme also did not appear to be cost-effective, control of the water level in the Basin with a pumping station became the one positive and economically feasible method of achieving the desired results.

Moreover, the findings of the Charles Interim Report submitted 29 May 1968 documented the need for enlarged locks at the mouth of the Charles and means of discharging excess Basin waters to Boston Harbor against the tide during the nearly ten hours daily when the harbor level is equal to or higher than Basin level. The existing single navigation lock at the Charles River Dam is inadequate for handling the ever-increasing recreational and commercial boat traffic requiring access to the Charles River Basin. Completed in 1910, the lock is even now the cause of considerable congestion and delay with a service load of some 1,100 vessels. As the fleet of pleasure craft and transient trailers increases to 2,550 by the year 2020, navigational problems will grow steadily more pronounced. Because the sole existing lock cannot be economically enlarged and additional locks at the same site are not feasible, the optimum plan for permanently removing the Charles bottleneck calls for abandoning the existing lock and providing new ones.

To meet both these needs, the Interim Report recommended construction of a multiple-purpose dam in the Charles River in the vicinity of Warren Avenue, Boston. In addition to three navigation locks, the

CHARLES RIVER LOCKS AND DAM

new dam will include a large pumping station and the foundation for an overhead traffic viaduct. Under normal conditions, conduits will discharge excess Basin inflow to tidewater. During a flood threat, pumps would provide such discharge to eliminate lowland and sewer flooding. Saltwater intrusion into the Basin would be virtually eliminated, and a fish passage facility will be included to afford immediate access to habitat upstream to the Bleachery Dam at River Mile 11.8. In all cases, the preservation and enhancement of the highly-prized urban environment created by the lower Basin remains a prime engineering consideration.

2. The Middle and Upper Charles

In the past, flood damage in the Middle and Upper Charles watershed has not been major. There are buildings subject to flooding, but their total number and the associated monetary losses are relatively small.[7] Although it would appear that at the present time no structural improvements are warranted, serious problems are inevitable unless strong corrective measures are sought to hold future flood losses to a minimum. If the upstream natural valley storage areas are not preserved and uncontrolled urban development continues, many areas not previously susceptible to flooding will suffer serious flood damages in the near future.

Because the prevention of flood damage is far more costly and difficult after urbanization has taken place, the Committee recommends that local action be taken first to prevent additional building in flood-prone areas. This could be accomplished through enactment and implementation of flood plain regulations such as zoning, sub-division regulations, building codes, and health regulations. Watershed communities which have had the foresight to institute flood plain zoning already are shown in Table 8.

7 As noted above in Part III, D, concentrations of industrial and commercial properties are located in Waltham, in Newton, at an office park in Wellesley, at an industrial center on the Newton-Needham line, a shopping center in Dedham, and in an industrial park on the Boston-Dedham line. Upstream of Dedham there is no industrial or commercial development as such.

Next, assistance should be given those who have already located in flood-prone areas. Typical measures would include flood proofing of buildings, long-term evacuation programs and flood insurance. Flood damage can also be reduced appreciably by taking evasive or protective action based on flood predictions and warnings. Although the effectiveness of warnings varies greatly depending upon the action time allowed between the predicted flood and its occurrence, studies have shown that on the average about ten percent of flood damages could be avoided through proper reaction to flood forecasts. Reaction can take the form of temporary flood proofing of stationary equipment and machines, the evacuation of goods, or the building of temporary protective works.

Finally, efforts should be made to secure control of critical flood-influencing land. These efforts should be made at all levels of government; community, state, and Federal, and also through the influence of citizens and private groups. Considerations should include watershed land-use control measures and the clearing of debris from water courses.

As discussed above, the fact that the Charles River watershed has not yet had a serious flood problem is due to the modifying effect of swamps and marshes on high flows. These areas store water that would create flooding and gradually release them without causing serious damage. The capacity of the valley storage in the Middle and Upper Charles has been hydrologically determined and prime sites for acquisition have been identified. Figure 8 and Tables 9 and 10 show the 17 wetland areas suggested for preservation.

In area, storage sites recommended for acquisition total about 8,500 acres located in 16 cities and towns. The size criterion applied - 100 acres minimum - was a Coordinating Committee decision based upon ease of wetland management. Area "A" which initially was thought to exceed the 100-acre limit upon field check was found to have been partially filled and substantially developed. It was, therefore, omitted from consideration at that time. Subsequently, local interests have indicated an intense desire to have area "A" included in the natural valley storage plan, and it will be reconsidered during the detailed engineering and design phase.

TABLE 8

CHARLES RIVER STUDY

COMMUNITIES WITH FLOOD PLAIN ZONING OR CONSERVANCY ZONINGS

City or Town	Percent of Area in Charles R. Watershed	Frontage on Charles River		Frontage on Principal Tributaries			City or Town Flood Plain Zoned		Flood Plain Zoning Adopted	Conservancy Zoning Adopted
		Left Bank Miles	Right Bank Miles	Name	Left Bank Miles	Right Bank Miles	Area Acres	Elevations MSL		
1. Ashland	4.3									
2. Arlington	6.3									
3. Bellingham	42.0	8.78	6.50	Hopping Brook	0.4	0.4				
				Beaver Brook	1.4	1.4				
4. Belmont	40.0									Yes
5. Boston	57.2	0.87	10.44	Muddy River	0.0	2.2				
6. Brookline	100.0			Muddy River	2.2	0.0				
7. Cambridge	64.6	6.13								
8. Dedham	66.9	6.17	6.87	Mother Brook			416	95	Yes	
				Diversion	0.1	0.1				
9. Dover	85.5		10.77	Trout Brook	2.0	2.0				Yes.
10. Foxboro	0.1									
11. Franklin	90.7		4.41	Shepard Brook	1.5	1.5	2,450	Varies	Yes	
				Mine Brook	5.0	5.0				
12. Holliston	99.5			Bogastow Brk	2.9	3.0				
				Chicken Brk	4.1	4.1				
				Hopping Brk	4.0	4.0				
13. Hopedale	18.8		1.77							
14. Hopkinton	10.2	0.26	0.26							
15. Lexington	29.5									
16. Lincoln	61.3			Stony Brook	3.0	3.0				Yes
17. Medfield	78.1		9.06	Stop River	2.0	2.0	1,415	125	Yes	Yes
18. Medway	100.0	5.78	1.17	Chicken Brk	3.3	3.3				
				Hopping Brk	2.2	2.2				
19. Mendon	1.6		0.91							
20. Milford	86.3	5.64	4.90	Lake Louisa						
				Outlet	0.3	0.3				
21. Millis	100.0	0.27	1.61	Bogastow Brk	4.5	4.5	1,280	125	Yes	
22. Natick	55.2	2.95	2.87	Davis Brook	2.0	2.0				
				Indian Brook	1.8	1.0				
23. Needham	100.0	1.93		Fuller Brook	1.5	1.5	672	Varies	Yes	
24. Newton	100.0		11.88					Varies	Yes	Yes
25. Norfolk	99.7		2.04	Mill River	1.5	1.5	800	Varies	Yes	Yes
				Stop River	2.0	1.0				
26. Sherborn	83.4	4.65		Indian River	0.5	1.5	343	125	Yes	
				Farm Pond						
				Outlet	0.5	0.5				
				Sewall Brk	3.0	3.0				
				Bogastow Brk	0.1	0.0				
27. Somerville	33.9									
28. Walpole	1.0			Stop River	0.0	1.0			Yes	
29. Waltham	100.0	3.21	2.72	Stony Brk	2.0	0.0				
30. Watertown	86.3	4.47	0.70							
31. Wayland	2.6									
32. Wellesley	100.0	5.24		Waban Brk	0.5	0.5			Yes	Yes
				Fuller Brk	2.8	2.8				
33. Weston	91.0	2.59		Stony Brk	2.5	4.7				
34. Westwood	34.0		0.06							
35. Wrentham	43.4									

NOTES: Left or Right bank designations are moving from source to mouth.
Principal tributaries are limited to non-urban waterways
Areas of flood plain zoning are based on approximate measurements on USGS Maps 1" = 2,000

Natural valley storage was by no means the only flood control alternative considered. Structural means also figures prominently in the study; retention reservoirs upstream of damage areas, concrete walls or earthen dikes to straighten and channelize portions of the stream, etc. All of these techniques, however, threatened adverse consequences for the quality of the environment.

Early in the study an analysis was made of potential flood storage reservoir sites. As expected, optimal reservoir locations fell in the natural valley areas since the greatest amount of water could be stored there for the least height of dam. Reservoir sites for flood control, low flow augmentation, and recreation considered in detail were in South Natick, North Bellingham, and Millis. Later, these sites were eliminated because of the small benefits produced, high real estate costs, adverse effects on water quality in their relatively shallow pools and nutrient problems hastening their eutrophication.

Tributary multiple-purpose flood control reservoirs were studied by the Soil Conservation Service of the Department of Agriculture in cooperation with the Corps. Preliminary investigations were conducted on 47 potential impoundment sites. All but 12 of these were found to be unfeasible because of poor site conditions or land rights problems. Of the remaining twelve sites, 7 were eliminated because they conflicted with the natural valley storage program. Generally, flood control reservoirs are impractical in the Charles River Basin because of the limited amount of drainage area that can be controlled and because flood damages are not significant in the upstream tributaries.

Consideration was also given to the effect of flood flow diversion on Mother Brook and the Neponset River. The 1968 flood demonstrated that the non-damaging capacity of the brook is approximately 1,000 c.f.s. Apprehension by abuttors about rising stages caused the M.D.C. to check the rate of diversion. Findings indicate that diverting flood flow from the Charles would cause extreme problems on Mother Brook and that the maximum rate of diversion should not exceed 1,000 c.f.s. (See Appendix D, Hydrology and Hydraulics).

Finally, local protective works were also considered. These would include not only diking and walling along extensive sections of the river adjacent to high damage areas, but dredging and concrete lining to

increase channel flow in other sections. Again both dollar and environmental costs were thought to be excessive. A local protection layout made for a ten-mile length of river considered to be highly flood prone resulted in a cost estimate of $30 million. Beyond exorbitant construction cost, social and environmental impacts were unacceptable; disruption of traffic, causing hardship to local merchants and inconvenience to the public, and the extinction of a lovely stream. Evacuation from and relocation of structures in flood prone areas proved to be even more costly than local protection for existing buildings. [8]

- Protection Through Preservation

If not preserved through an aggressive land acquisition plan, the utility and beauty of essential wetlands will be forever lost. If the Route 128 experience is repeated in the Upper and Middle Charles, wetlands will be filled and river banks lined in the search for buildable space. Unlike true marshes, these "wet meadows" are easily drained, filled, and developed. If no restrictions are made, in twenty years upstream communities will be replicas of the Lower Charles cities; their tangle of roads, asphalted parking lots and steamy rooftops.

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8 In some isolated cases, of course, flood proofing is strongly indicated; a home in Medway, an office park in Wellesley, etc. Competent firms can handle individual problems with window sealing, watertight bulkheads and temporary closures used only when flooding is imminent.

Further, in communities which have experienced flood damage, individuals should investigate the National Flood Insurance Program administered by the Federal Insurance Administration of the Department of Housing and Urban Development (HUD). This program utilizes services of the private insurance industry and provides for Federal subsidization of flood insurance on single to four-family structures and small business properties and their contents. The insurance covers damage caused by overflow of either inland or tidal waters on flood-prone land. Upon submission of satisfactory evidence of positive interest, a community is placed on a list of those eligible for rate-making studies. When the rate-making study has been completed and satisfactory assurances of land use and control measures submitted, a community is declared eligible for flood insurance and its property owners may obtain coverage.

It should be noted that protection through preservation is not an idea imposed from the Federal level. Many town planning reports have acted to protect river areas and marshes through flood plain zoning, established conservancy districts or recommended outright town ownership. By enacting comprehensive land use plans and zoning ordinances, municipalities have demonstrated a sensitivity for wetlands protection and the need to channel development. As flood control areas and simply as lovely places for wildlife and passive recreation, wetlands have proven to be an excellent public investment generating multiple returns.

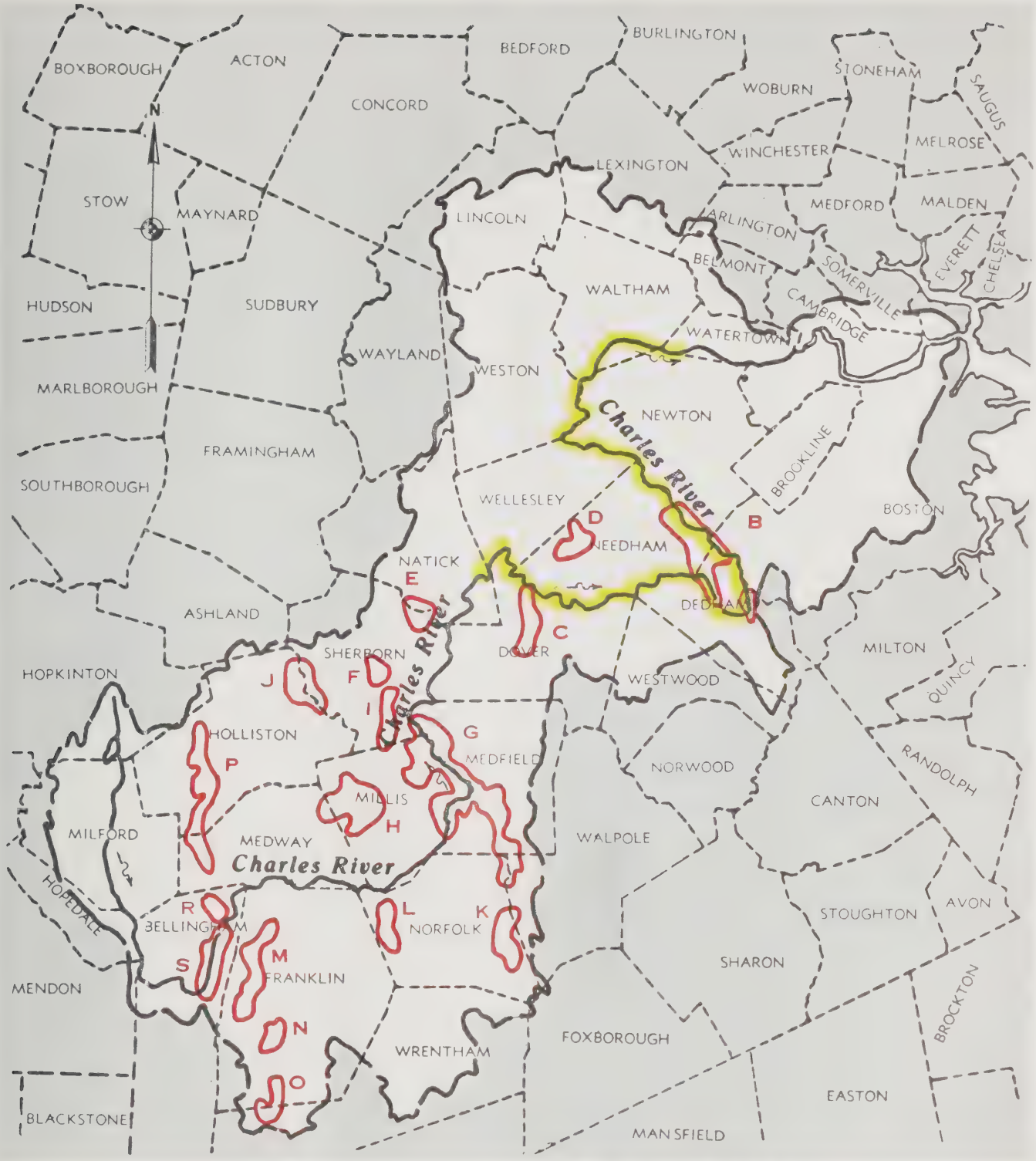
PART V: DETAIL OF RECOMMENDED FLOOD MANAGEMENT PLAN

The flood protection needs of the Middle and Upper Charles Watershed can be satisfied without costly and environmentally disruptive new structures. By acquiring the natural valley storage areas in this region, the Federal government can at once achieve its flood control objective and realize bonus benefits in recreation and wildlife conservation. Such a strategy is fully compatible with state and local legislative intents and the expressed concerns of private citizens' groups. But timing is the critical element. Unless acquisition proceeds rapidly now, the opportunity to implement a natural solution to an inescapable problem will be forever lost. Once the tide of development comes and the filling of wetland areas begins, there is no return.

A. QUALITATIVE ASPECTS

1. Development of Project System

The total extent of swamps, marshes, and wet meadows in the Charles River Watershed is estimated to be approximately 20,000 acres in parcels ranging from less than one to more than 2,300 acres. Although it was known that each wetland area accounted for some portion of overall storage capacity, the acquisition of rights over every site with flood control potential was considered impractical. Hence, by establishing selection criteria, the Charles Study team attempted to discriminate among wetland areas to identify those most crucial to a comprehensive water management plan. One standard for evaluation was hydrologic performance. Using the March 1968 flood as representative of the flood of record, project engineers noted the extent of inundation in storage areas. Approximately 10,000 acres located in nineteen areas immediately adjacent to the Charles or on a large tributary were selected as having superior flood retention capabilities. Added to these data were management-oriented considerations; 100 acres emerged as the minimum size for ease of Federal purchase and administration. Smaller areas not only offered proportionately less capacity per unit of area, but they were impractical as components of a management



CHARLES RIVER WATERSHED

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

0 5

SCALE IN MILES

NATURAL VALLEY STORAGE AREAS

AREA OF HIGH LOSS POTENTIAL

FIGURE 8

system. Indeed, not all areas containing more than 100 acres were selected for protection where more convenient, primary storage sites were considered adequate.[1]

Geographically, the natural valley storage areas identified in this way appear to be separate units scattered uniformly across the watershed. Hydraulically, however, they behave as a single, integrated storage system which retards and desynchronizes flood flows by routing them sequentially from one area to another. By contrast with the rapid transmission of water in a continuous stream, it is the very inefficiency of transmission that is desirable. In effect, the system behaves like a single flood control reservoir broken into many separate pieces.

As a system, the natural valley storage areas included in the recommendations of the Division Engineer have provided and, with protection, will continue to provide substantial flood control for all events as great as the Standard Project Flood. The seventeen areas utilmately designated as project components are estimated to control 75% of Charles wetland and lake storage or about 42,000 acre-feet.[2] Since the 1968 flood provided an opportunity to observe wetland behavior in a situation comparable to that of the flood of record (1955), engineers studied the extent of inundation in detail. They concluded that the elevation of the 1968 flood would be the appropriate "design height" of acquisition in the natural valley areas considered for the project.

---

1 The nineteen areas originally identified were reduced to seventeen when two areas were found to have been sufficiently developed to impair their flood water retention capability. In light of citizen concern for protecting even these areas, one, designated "A", is being reconsidered for inclusion in the recommended plan.

2 Appendix D, Hydrology and Hydraulics, discusses the hydrograph analysis performed to calculate the storage capacity of the upper watershed. Findings indicated that during the August 1955 flood of record approximately 50,000 acre-feet, the equivalent of about five inches of runoff from a drainage area of 184 square miles, were stored above the gage at Charles River Village.

Next, to optimize the unit cost per area, a real estate appraiser made field checks of every wetland designated for Federal control. Simultaneously, to determine compatibility with the intentions of local planning bodies, study engineers reviewed town master plans for their treatment of wetland areas. However, no attempt was made to analyze the cost benefit economics of individual areas because each was considered to be an integral part of the overall hydraulic chain. Should one be excluded and its storage capacity eventually lost, the integrity of the whole system would be undermined. That is, the next downstream storage area would be overtaxed and produce increased periphery flooding. Then, from the flood management standpoint, the only practical solution would be to improve drainage in this second storage area -- voiding the storage effectiveness for which it was acquired and moving the problem of excess flows progressively downstream.

2. Forms of Acquisition

The natural valley storage areas selected may be protected by acquisition in fee or preserved in their natural condition through easements restricting building and filling on wetlands. To eliminate the cost of purchasing buildings situated on land contiguous to the wetlands, acquisitions will not include improved sites. Nor will access to improved properties within prospective sites be restricted. In those instances where utilities or municipal or State facilities such as pipelines, electric or telephone lines, etc., fall inside a site, it is assumed that a permit or easement will be granted to allow them to remain in place. Where substantial amounts of high land are surrounded by a site, access will be granted over the wetland areas to avoid the creation of landlocked property.

For individual owners who would not favor outright acquisition, the option of having an easement placed on their land will be considered. Through permanent easements, private owners would retain the right to live on the land and enjoy any other rights not specifically acquired Moreover, the public would obtain not only the right to prevent the alteration of drainage characteristics, but to manage lands for maximum fish and wildlife productivity. In addition to rights of restricted access, the government would enjoy the privileges of habitat manipulation, installation of nature trails and outdoor education facilities and any facilities to maintain a Federal refuge.

MEDFIELD-MILLIS WET MEADOW
NORMAL SPRING HIGH WATER

Table 9

NATURAL VALLEY STORAGE AREAS

Designation	Stream	Acreage	Communities
A	Beaver Brook (To be reconsidered)		Lexington-Belmont-Waltham
B	Charles River	1,029	Needham-Newton-Boston-Dedham
C	Trout Brook	250	Dover
D	Fuller Brook	284	Needham
E	Indian Brook	234	Natick-Sherborn
F	Sewall Brook	118	Sherborn
G	Charles & Stop Rivers	2,340	Norfolk-Sherborn-Medfield-Millis
H	Bogastow Brook	907	Medway-Millis
I	Tributary to Bogastow Brook	280	Sherborn
J	Dopping Brook	130	Holliston-Sherborn
K	Stop River	395	Norfolk
L	Mill River	360	Norfolk
M	Mine Brook	395	Franklin
N	Mine Brook	150	Franklin
O	Miscoe Brook	266	Franklin-Wrentham
P	Hopping Brook	704	Holliston-Medway
R	Stall Brook	180	Bellingham
S	Charles River	400	Bellingham

Table 8

RECOMMENDED ACQUISITION SITES, BY TOWN

Town/City	Wetland Acreage (acres)
Millis	1,797
Medfield	1,177
Norfolk	827
Franklin	731
Holliston	694
Needham	684
Sherborn	674
Bellingham	580
Dedham	500
Dover	250
Medway	180
Newton	100
Wrentham	80
Walpole	75
Natick	44
Boston	29

3. Management of Natural Valley Storage Areas

The natural valley storage areas, acquired either by purchase or through easement, will be maintained by the United States under the supervision of the Division Engineer, Corps of Engineers, Waltham, Massachusetts. The acquired areas acting as a flood control reservoir will be maintained for the reduction of flood flows throughout the entire watershed and for potential high damage communities downstream. Periodic inspection of the natural valley storage areas will be made by Division personnel to insure that the areas remain in their natural state.

Although the primary purpose of preserving the wetland areas will be for flood management, much of the wetlands protected will be managed as a wildlife refuge with limited public access. Table II lists categories of ownership for the 17 natural valley storage areas. The 6,184 acres now in private hands will be considered as a potential addition to the National Wildlife Refuse Program of the U. S. Bureau of Sport Fisheries and Wildlife, Department of the Interior.[3] The 429 acres maintained in perpetuity by Trustees of Reservations and the Massachusetts Audubon Society will continue essentially in its present use. Property classed as municipal (589 acres) will be evaluated for its present use as well as its adaptability for a refuge. The 1,220 acres owned by the Commonwealth is currently divided as follows:

(1)	Corrections Department	77 acres
(2)	Mental Health Department	390 acres
(3)	Department of Natural Resources	105 acres
(4)	Metropolitan District Commission	648 acres

With the exception of category (4), State property will probably continue in its present use, subject only to the right of flowage during flood periods. The 648 acres of wetlands presently owned by the Metropolitan District Commission is being considered by that agency for low intensity recreational use. On this acreage, a flowage easement is sufficient for flood control purposes. However, if it is the wish of the State, the Federal government is willing to acquire the land and make it available under long-term lease arrangements assuming, in addition, one-half of the separable first cost of recreation facilities, in accordance with P. L. 89-72. During the advanced engineering and design

3 Based on similar units in the National Wildlife Refuge System, the annual costs of operation and maintenance will be approximately $50,000.

stage of the study, an investigation will be made to determine if there are suitable opportunities for recreational development. The Commonwealth of Massachusetts has indicated its support for Federal assistance should recreational opportunities materialize. See Attachments for letter of comment 2 May 1972 from the Commonwealth of Massachusetts.

It is a safe assumption that a large number of landowners will prefer easements to sale of their property; the actual amount of land to be acquired in fee will not be known until acquisition procedures begin. A factor to be considered in deciding the form of acquisition, i.e. fee or easement, will be the efficiency of project administration and maintenance. Once that determination has been made for each parcel, detailed procedures for management can be drawn up and a cooperative agreement written with the responsible agency. Also consideration will be given to coordinating the protection and management elements of the plan at a single level of government.

4. Wetlands Outside the Project

As noted above, there are approximately 20,000 acres of wetland area in the entire watershed. Of this total, about 8,500 acres of wetland have been designated by the Corps as having significant flood water retention capabilities to be included in the multiple resource management plan for the Charles River watershed. Federal acquisition will effectively protect these properties, but the fate of the remaining 11,500 acres of natural storage is also important to flood control in the Middle and Upper watershed. This is land outside both the Corps flood management plan and the Department of Natural Resources Corridor Plan; small wetland areas that individually have a less significant regional effect on flood run-off than do larger areas. The alarming development trends discussed earlier apply equally to these properties Some manner of land use control is imperative for as even these smaller areas are developed and graded, increased run-off will overstress streams and abutting major wetlands.

Fortunately, most communities still have enough open space to make the course of future development a matter of choice. Time, however, is running out. Before development pressures become irresistably strong, municipal authorities and private citizens should take advantage of the Commonwealth's aid program for green space preservation. Through their Conservation Commissions, towns may receive up to 75% (50% Federal, 25% State) financial assistance on acquisition projects. Other restrictions short of purchase can also be effective; gifts, conservation easements, and zoning. Whatever the means, delay means the forfeiture of inestimably valuable public benefits.

Table 11

OWNERSHIP OF NATURAL VALLEY STORAGE AREAS
- ACRES -

Area	Private	Private Conservation Soc.	Municipal	State	Total
A	To be reconsidered				
B	342	-	39	648	1,029
C	228	-	22	-	250
D	241	-	43	-	284
E	34	200	-	-	234
F	112	-	6	-	118
G	1,676	229	358	77	2,340
H	891	-	16	-	907
I	280	-	-	-	280
J	127	-	3	-	130
K	5	-	-	390	395
L	360	-	-	-	360
M	393	-	2	-	395
N	145	-	5	-	150
O	161	-	-	105	266
P	624	-	80	-	704
R	165	-	15	-	180
S	400	-	-	-	400
Totals	6,184	429	589	1,220	8,422

B. QUANTITATIVE FACTORS

1. Real Estate Cost Estimates

The figures developed for Table 12 are based on the assumption that no construction will occur on designated sites, and, consequently, that there will be no flood damages to existing improvements from other than natural sources. Two sets of real estate cost estimates have been prepared to optimize acquisition expenditures.

> Plan No. 1 assumes that all low lands situated within the areas designated as natural valley storage areas would be acquired. In the case of improved lots or potentially developable lots, it proposes that only restrictive easements over the very low portions of lots (rear or side yards) be required. Thus future uses of the higher front portions would remain unaffected.
>
> Plan No. 2 contemplates only the acquisition of major parcels of wetland areas and no rights over any portion of already developed lots or potentially developable lots. This plan greatly reduces the acquisition costs and the number of individual ownerships affected.

The $2 million difference between Plans 1 and 2 reflects a change in the limit of the taking line. Plan No. 1 takes to a given elevation without regard to property line. Plan No. 2 on the other hand skirts 177 property owners. By omitting marginal rear lot areas, total land area is reduced by only 313 acres but the cost difference is an impressive $2 million. Thus, if the taking line is not modified, the project will cost 25% more for less than 4% additional land. Since these areas abut the more frequently wetted land and since they are individual lots, it is felt that they are not threatened by further development. Therefore, the recommended plan for acquisition is Plan No. 2: 8,422 acres at an estimated cost of $7,000,000 excluding the lands held in perpetuity by the Trustees of Reservations and the Massachusetts Audubon Society. Although many owners will prefer easements, the Real Estate estimate is based on current real estate policy, as established by Public Law 91-646, 91st Congress, S. 1, wherein full fair market value of property is allowed. It is this higher cost that is used in the cost justification.

Table 12

PRELIMINARY ESTIMATE OF REAL ESTATE COSTS

Area	PLAN NO. 1				PLAN NO. 2			
	Area (Acres)	No. of Owners	Land Value	Total R/E Costs	Area (Acres)	No. of Owners	Land Value	Total R/E Costs
A	To be reconsidered							
B	1,050	75	$ 1,212,000	$ 1,780,000	1,029	42	$ 1,029,000	$ 1,500,000
C	285	68	355,000	600,000	250	33	205,000	380,000
D	310	54	340,000	560,000	284	22	203,000	350,000
E	250	14	219,000	360,000	234	8	189,000	320,000
F	135	24	140,000	250,000	118	10	95,000	170,000
G	2,400	250	807,000	1,500,000	2,340	210	603,000	1,200,000
H	960	74	454,000	780,000	907	70	304,000	590,000
I	315	27	340,000	530,000	280	17	226,000	380,000
J*	130	12	51,000	100,000	130	12	51,000	100,000
K	400	3	152,000	240,000	395	2	136,000	220,000
L*	360	16	125,000	230,000	360	16	125,000	230,000
M	400	55	266,000	480,000	395	20	196,000	350,000
N	150	14	80,000	160,000	150	14	80,000	160,000
O	275	26	120,000	240,000	266	26	90,000	200,000
P	735	135	431,000	850,000	704	68	259,000	550,000
Q**	---	---	---	---	---	---	---	---
R*	180	13	117,000	220,000	180	13	117,000	220,000
S*	400	20	196,000	350,000	400	20	196,000	350,000
Totals	8,735	880	$ 5,405,000	$ 9,230,000	8,422	603	$ 4,104,000	$ 7,270,000

*Single Acquisition Plan
**Eliminated from Consideration

2. First Cost and Annual Charges

The estimated total first cost of project is $7.34 million of which $7 million is the real estate cost. Real estate investigations included a physical inspection of each area to determine the type of property involved, present use, highest and best use, and physical characteristics. Where available, assessors' property maps were consulted. Moreover, a preliminary market study was conducted in the vicinity of each designated natural valley storage area. Personal contacts included real estate brokers, appraisers, local assessors, several town engineers and building inspectors, members of community conservation commissions and other local and state officials or private individuals with a general knowledge of real estate values for a given area. As a result of the investigation into recent property transfers comparable to those affected by the proposed acquisition program, the values used in the cost estimates are considered to be representative of fair market value.

The balance of $340,000 is designated for engineering and design to more accurately fix the high water line within selected natural valley storage areas. Photogrammetric surveys and detailed hydraulic analysis are included, together with the costs of preparing a master plan for each area and certain special studies.[4]

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4 These include (1) analysis of the mechanisms necessary to facilitate joint local, state and Federal project cooperation, (2) equitable tax adjustments, and (3) regional guidance on resource planning objectives. It should be noted on the issue of potential tax revenue losses to communities that Chapter 58 of the Massachusetts General Tax Law provides for reimbursement of "taxes lost by reason of property taken for flood control reservoirs either by the state or other Federal agencies". Thus, since the natural valley storage system for the Charles is viewed as one reservoir, the statute offers localities compensation contingent on favorable action by the legislature.

2. First Cost and Annual Charges

Table 13

SUMMARY OF FIRST COSTS AND ANNUAL CHARGES
(1971 Price Level)

Plan First Cost	
Land value*	$ 3,834,000
Severance damages	952,000
Administrative costs	723,600
Boundary marking	287,200
	$ 5,796,800
Contingencies	1,203,200
Total real estate cost	$ 7,000,000
Engineering and design	340,000
Total Plan First Cost	$ 7,340,000
Annual Charges (100 year life)	
Interest (5-3/8% or 0.053750)	$ 395,000
Amortization (0.00028)	2,000
	$ 397,000
Operation and Maintenance	80,000
Annual Charges	$ 477,000

*Includes state-owned land but not land owned in perpetuity by the Massachusetts Audubon Society and the Trustees of Reservations.

The total annual charges amount to $~~447,~~ 477,000; interest on the total investment, its amortization over a 100-year life, and all anticipated operation and maintenance charges. This latter estimate of $80,000 is based on the record of expenditures made at the adjacent Great Meadows Refuge in Concord together with the costs of inspection and surveillance by Corps personnel. Because the productivity of the land ascends monotonically, no estimates for replacement items appear. Also possible loss of productivity of lands to the communities, brought about by project implementation was given consideration; however, any loss of productivity would be more than offset by enhancement to surrounding lands.

3. Benefits

The benefits for the Lower Charles River issue from the construction of the multi-purpose Warren Avenue dam described in the Interim Report of May 1968. The benefits projected for the Middle and Upper Charles River area relate to minimizing future flood losses and protecting the ecologic integrity of a fragile environment.

Tangible Items

The recommended acquisition of 8,422 acres of wetlands will minimize increases in annual flood damage due to the loss of valley storage. Benefits are reckoned as the difference between annual losses under present land use conditions and those associated with the projected 1990 loss of 30% of valley storage.[5] Annual benefits so derived amount to $647,000 on an average annual equivalent basis. Beyond flood control

5 The methodology underlining such computations is based on hydrographic analysis to determine the effect of shrinking natural valley storage on flood flows. The volume of flood water was correlated with the amount of storage anticipated in several future years, i.e., at lower and lower wetland acreages. Other hydrographs assuming varying degrees of upstream storage were developed empirically using comparable flood volumes but with higher peaks in shorter time periods. The resulting stage vs. loss of wetland curves were the source of potential damage figures for increased flood heights. See Appendix D, Hydrology and Hydraulics, for fuller detail.

benefits, the wetlands acquired have an average annual conservation benefit of $124,800.

TABLE 14

BENEFITS*

Description	Gain in benefits with project
Trout Stream Fisheries	4,200
Warm Water Fisheries	7,500
Wildlife Habitat - Wetlands	38,800
Wildlife Habitat - Water Fowl Hunting	45,700
Nature Study	28,600
TOTAL	124,800

*Does not include benefits accrued if the areas are developed and managed under the wildlife refuge system.

Intangible Items

Less amenable to quantification are certain other benefits attributable to the project.

> By protecting marsh areas inundated each spring, their continuing spring recharge to groundwater aquifers is assured. The productivity of existing well fields is thereby protected.
>
> Natural flow augmentation of the main stem during periods of reduced precipitation will not be disrupted.
>
> The greenbelt created in the Middle and Upper Charles becomes an aesthetic haven for nearby urban populations otherwise condemned to the unremitting pressure of city life. Further, their enjoyment of the natural world

comes only at the expense of unwise development in the host communities. With careful attention to the equitable distribution of costs and benefits, a mutually satisfying symbiosis between urban and hinterland interests can be built.

By inclusion in the National Wildlife Refuge System, the Charles Watershed can be built into a superior waterfowl breeding area. This together with low-intensity recreational use will extend the pleasures of contact with the natural world to non-resident populations.

4. Economic Justification

A comparison of average annual benefits and average annual charges is as follows:

TABLE 15

BENEFIT TO COST RATIO

Average Annual Benefits	
Flood Control	$647,000
Recreation and fish and wildlife benefits provided by preservation of wetlands	124,800
	$771,800
Average Annual Charges	477,00 ~~447~~,000
Benefit/Cost Ratio	1.6 to 1.0

Benefits attributed to recreation and fish and wildlife because of wetlands preservation are not accounted separately and do not include those realized should the wetlands be enhanced as part of a National Wildlife Refuge System. Because of the incidental nature of these benefits, it is assumed that all costs of the project will be met with the funds of the United States. However, local cooperation is required to submit plans for any proposed constructions which could affect the existing drainage characteristics in the natural valley storage areas. Non-Federal interests are, therefore, requested to enforce legislation affecting riverbank filling strictly, to maintain existing dams, to retain public lands, and to extend legislative relief to communities subject to potential tax losses.

C. CONCLUSIONS AND RECOMMENDATIONS

Flooding in the Middle and Upper Charles is not now a serious problem, but with continued encroachment on the flood plain and loss of wetlands due to urban expansion, heavy damages will occur in future floods. In the event of a recurrence of the flood of record, losses would amount to over $12 million by the year 2020 with a stage four feet higher.

It is concluded that the magnitude of such potential flood losses is sufficient to warrant the acquisition of the natural valley storage areas described in this report. It is further concluded that the watershed plan as proposed by the Coordinating Committee be used as a guide for the immediate and future resource development of the watershed.

Therefore, the Division Engineer recommends that Federal acquisition in fee or by easement of the major natural valley storage areas within the Charles River Watershed be authorized as a multiple-purpose project for flood control, recreation, and fish and wildlife management and that further study be made during the pre-construction stages for the inclusion of Area A. He proposes that the project be implemented as it is presented in this report with such modification as the Chief of Engineers may deem advisable. The presently estimated first cost of the project is $7,340,000 for 8,422 acres designated as natural valley storage and the annual benefit to cost ratio is 1.6 to 1.0.

D. ITEMS OF LOCAL COOPERATION

The Division Engineer further recommends that local interests will:

1) Submit for approval by the Division Engineer any proposed alteration or modification of existing roadways, utilities, and bridge or culvert openings which could affect existing drainage characteristics in the natural valley storage areas.

2) Enforce and enact legislation to restrict development of publicly and privately owned lands which fall within the designated flood plains. Such action is needed to complement the storage capacity of approximately 42,000 acre-feet provided by Federal acquisition of natural valley storage areas.

3) Obtain or retain existing dams along the Charles River and its tributary streams, maintaining them in operable condition.

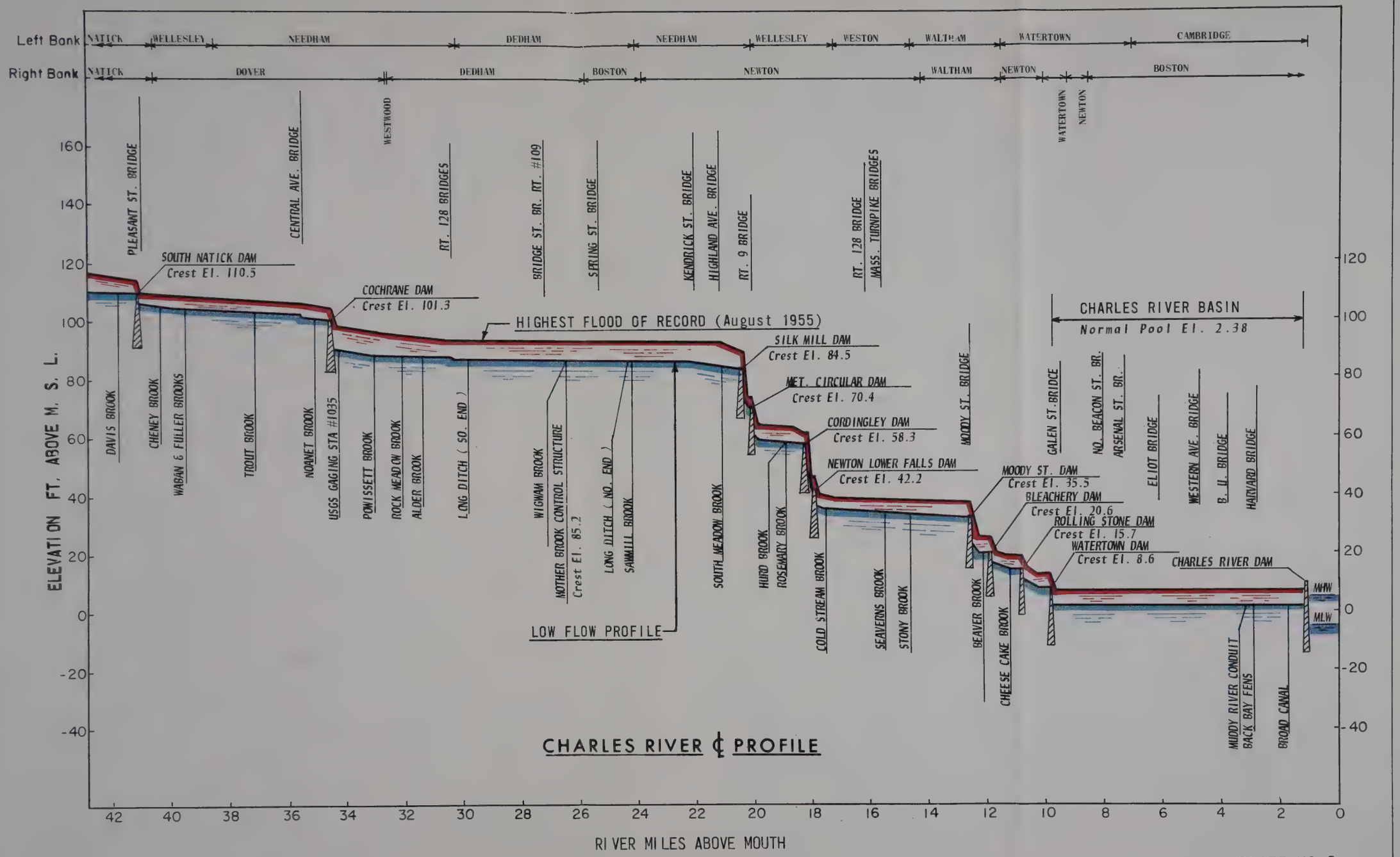
4) Commit to public park or reservation purposes all existing or future properties acquired along the Charles River with public funds.

5) Provide a mechanism through which communities can be reimbursed for taxes lost through Federal acquisition of land, in fee or by easement, for natural valley storage.

6) Agree to cost share under provisions of P. L. 89-72, should suitable opportunities for recreation development materialize during the post authorization phase.

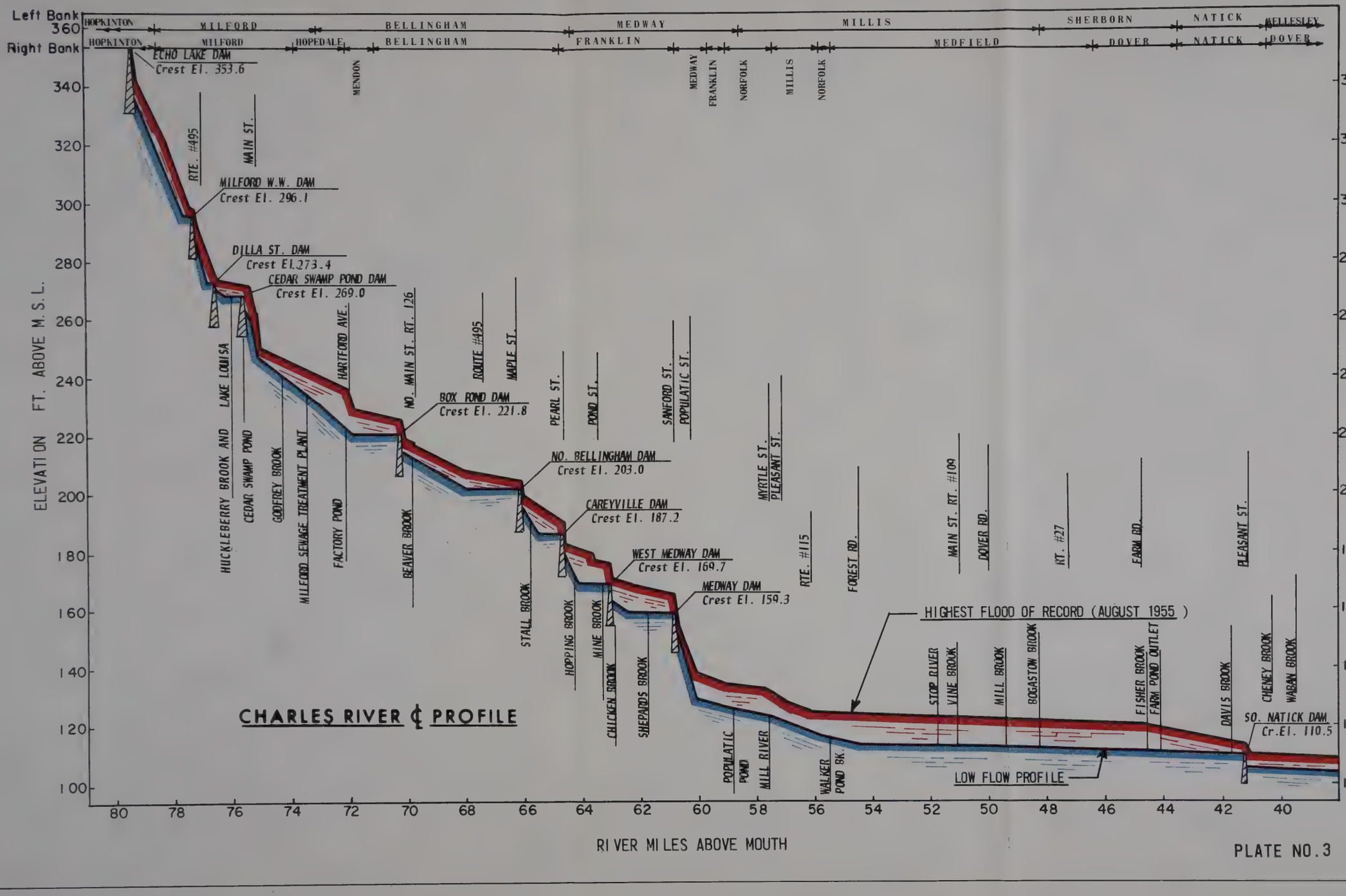
2 Incl
1. Attach I & II
2. Appendices A through H

FRANK P. BANE
Colonel, Corps of Engineers
Division Engineer



CHARLES RIVER ℄ PROFILE

PLATE NO. 2


Left Bank
Right Bank
HOPKINTON
MILFORD
HOPEDALE
BELLINGHAM
MEDWAY
MILLIS
SHERBORN
NATICK
WELLESLEY
FRANKLIN
MEDFIELD
DOVER
MENDON
NORFOLK
ECHO LAKE DAM
Crest El. 353.6
RTE. #495
MAIN ST.
MILFORD W.W. DAM
Crest El. 296.1
DILLA ST. DAM
Crest El.273.4
CEDAR SWAMP POND DAM
Crest El. 269.0
HUCKLEBERRY BROOK AND LAKE LOUISA
CEDAR SWAMP POND
GODFREY BROOK
MILFORD SEWAGE TREATMENT PLANT
FACTORY POND
HARTFORD AVE.
BEAVER BROOK
NO. MAIN ST. RT. 126
ROUTE #495
MAPLE ST.
BOX POND DAM
Crest El. 221.8
PEARL ST.
POND ST.
SANFORD ST.
POPULATIC ST.
NO. BELLINGHAM DAM
Crest El. 203.0
CAREYVILLE DAM
Crest El. 187.2
STALL BROOK
HOPPING BROOK
MINE BROOK
CHICKEN BROOK
SHEPARDS BROOK
WEST MEDWAY DAM
Crest El. 169.7
MEDWAY DAM
Crest El. 159.3
POPULATIC POND
MILL RIVER
WALKER POND BK.
MYRTLE ST.
PLEASANT ST.
RTE. #115
FOREST RD.
MAIN ST. RT. #109
DOVER RD.
RT. #27
FARM RD.
PLEASANT ST.
HIGHEST FLOOD OF RECORD (AUGUST 1955)
STOP RIVER
VINE BROOK
MILL BROOK
BOGASTOW BROOK
FISHER BROOK
FARM POND OUTLET
DAVIS BROOK
CHENEY BROOK
WABAN BROOK
SO. NATICK DAM
Cr.El. 110.5
LOW FLOW PROFILE
CHARLES RIVER ℄ PROFILE
ELEVATION FT. ABOVE M.S.L.
RIVER MILES ABOVE MOUTH
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
78
76
74
72
70
68
66
64
62
60
58
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54
52
50
48
46
44
42
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PLATE NO.3

ATTACHMENT I

SUMMARY REPORT

OF THE

CITIZENS" ADVISORY COMMITTEE

CHARLES RIVER STUDY

SUMMARY REPORT OF THE CITIZEN ADVISORY COMMITTEE

ON THE CHARLES RIVER WATERSHED

June 1971

This committee of concerned citizens, organized to advise the Corps of Engineers in its study of the Charles River watershed, has held twelve meetings and has attended meetings of the Coordinating Committee of cooperative agencies to which it was invited. We organized fourteen local meetings so that citizens could hear and discuss the proposals of the study.

This committee generally supports the report of the Corps study.

Implementation Phase

The watershed is experiencing environmental losses yearly and there is not time to make mistakes or omissions. Therefore, we recommend:

1. That the structure of coordination of agencies now in existence should not be lost and that the present Coordinating Committee's periodic meetings be continued.

2. That the Citizen Advisory Committee continue to exist.

3. That current information be made continuously available in order that citizen action can be effective on requests for funding and implementation.

Flood Plain Zoning

We endorse the emphasis on protection of flood plains in the watershed. We feel that the Corps study has been conservative in its fixing of elevations and that inevitable faster run-offs of the future will cause flooding at somewhat higher elevations. Therefore, we urge that local governments fix flood plain zoning elevations higher than those set by the Corps for the land protected in the natural valley storage areas.

Preservation of Wetlands

We endorse the emphasis on protection of natural wetlands in the watershed. We approve the proposal to use local, State, and Federal

funding to acquire or control wetlands designated as natural valley storage areas. Restrictions are preferable to purchase, if permanent restrictions can be negotiated with landowners who would then continue to pay taxes and to control access. We would wish to be assured that the recipient of the restriction has the duty (and, if necessary, the mechanism) to enforce this restriction. There was some concern that public ownership of wetlands might mean opening up the area for recreation, and we endorse acquisition only if recreation proposals are compatible with the nature of the area.

Impoundment Sites

Impoundment for low flow augmentation is not a cure for imperfect sewage treatment. Nevertheless, we support the recommendations of the Corps study for use of the following impoundment sites:

1. The Echo Lake site, No. 905, for water supply and possibly for recreation.

2. The Bellingham site, No. 902, for recreation. (1)

3. The smaller Milford site, No. 904, as a conservation area rather than as an impoundment.

4. The Franklin site, No. 912, for water supply

Corridor Report of the Department of Natural Resources

This excellent report was released only on May 13, and we have not the benefit of public reaction or of discussion in the Coordinating Committee. The acquisition or control of the banks of the river and major tributaries and of major bordering wetlands and some headwater slopes seems desirable. We support the concept, but want more information on funding and implementation. The proposal for a $25,000,000 State bond issue will depend on the likelihood of wide public support.

Water Pollution Control

The need for better sewage treatment is obvious. Tertiary treatment in the upper valley, and new methods of disposal of effluent from communities in the lower valley are indicated. It is estimated that 7/8's of the flow of the river will be effluent in the year 2020. Pollution problems in the harbor and ocean will soon require that all raw

(1) Subsequently, omitted from the coordinated watershed plan because of overlap with recommended natural valley storage area.

sewage be treated, so that increasing the size and length of sewers will not alone cure the pollution problems in the river. The whole problem of waste disposal and of urban run-off will require further study and more public information in the form of plans and actual costs. The river has to reach the designated classifications, and we support measures to reach and enforce these classifications. We commend the studies by the Metropolitan District Commission of plans for in-stream treatment and for upgrading the quality of the lower basin.

The Lower Basin and Warren Street Dam

As announced at an earlier date (see our letter to the U. S. Senate, March 25, 1970), we support the proposal for a new dam at Warren Street. In this connection, we urge that there be careful and creative planning of the adjacent land in the extended lower basin to provide additional areas for park and recreation.

The committee has also previously gone on record regarding future crossing of the river by a major highway in the Cambridge area. If such a highway is built, we favor a tunnel as being less disruptive of the beauty and recreational use of the river and shore.

Conclusion

Finally, we would like to state that the members of the various agencies and particularly the chair agency, the U. S. Army Corps of Engineers, were outstanding in their willingness to share information with citizens and to listen to our observations. We hope that this creative sense of working together will be translated into the successful period of implementation.

Thomas D. Cabot, Boston (Chairman)
John Plimpton, Sherborn(Vc Chairman)
Mrs. H. Shippen Goodhue, Wellesley (Secretary
Mrs. Talbot Baker, Millis
Charles Bartlett, Dedham
William H. Claflin, Belmont
Henry J. Colombo, Wilmington
Michael Ferris, Newton
Miss Karen Fischer, Boston
Mrs. F. Murray Forbes, Jr., Boston
John Gill, Needham
Francis J. Gottlich, Boston
Richard C. Hill, Bellingham
W. W. Horvath, Cambridge
Bruce Lund Natick
Alan Minoff, Cambridge (with reservation noted below)
Mrs. Thomas Murray, Franklin
Henri Prunaret, Natick
Nathan M. Pusey, Cambridge
Leverett Saltonstall, Dover
Robert T. Symonds, Milford
Daniel G. Wheeler, Dover
Walter M. Whitehill, Boston
Kenneth H. Wood, Norfolk

Reservations and Further Comments

(This dissent does not carry with it the implication that the Committee as a whole favors major highway construction in the basin area.

1. I do not feel that restriction is preferable to purchase of natural valley storage areas. Given that the study encompasses more than just optimum flood control, the potential of the wetlands for recreation and wilderness appreciation should not be overlooked. The protection of land through easement will deny to the general public any wilderness or recreation benefits which would accrue to the public through purchase. The scattering of the monitoring and enforcement mechanism (in regard to filling and other activities prohibited by easement) over many small towns will, in my opinion, leave these functions extremely vulnerable to lax administration and local pressure. I support acquisition with the condition that the land be used for compatible recreation.

2. Regarding the possibility of major highway construction in the basin area, the narrow strips of parkland in the basin exist, barely, in spite of the two highways flanking it. The last thing that the Boston Metropolitan area needs is more highways to jam with traffic, pollute the air, and further diminish the available market for mass transit facilities. I oppose all highway construction in the basin area - whether tunnel, bridge, or otherwise. This is with specific reference to the Cambridge Inner Belt, the Leverett Circle Bridge, of the widening of Memorial Drive.

(Signed) Alan Minoff

ATTACHMENT II

LETTERS OF COMMENT

CHARLES RIVER STUDY

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
18 Tremont Street
Boston, Massachusetts 02108
Tel. 727-7700

CHARLES H. W. FOSTER
Secretary

May 2, 1972

Colonel Frank P. Bane
Division Engineer
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Bane:

I am writing as a result of a meeting in my office on 6 April 1972 at which representatives of your staff reviewed with me and other state officials the summary findings of the Charles River Study.

The Corps' plan to preserve the crucial natural valley storage areas will provide a positive method for preventing flood damage through natural control of flood waters from the Middle and Upper Charles River watershed. We believe that the Commonwealth's on-going program for restricting construction under the Inland Wetlands Act will also significantly supplement the Corps' plan. In addition, the state is stressing the importance of wise flood plain management with a hope that those towns that have not enacted such programs will do so. It is my view that these actions will reduce and limit future flood losses. It will further help determine wise land use development patterns all in consonance with maintaining a high level of environmental quality.

The Corps' proposal for acquisition of about 8,500 acres of natural valley storage area is considered a particularly unique and refreshing approach to the flood management needs of the Middle and Upper Charles River watershed. As you know, the Commonwealth of Massachusetts is interested in a parallel and complementary program to protect both banks of the entire river. Preservation of about 22,000 acres is presented in the Commonwealth's Outdoor Recreation and Environmental Conservation Report which appends your report. The Corps' proposal to protect some 8,500 acres in 17 natural valley storage areas, if approved by Congress, would leave the remaining 13,500 acres to be protected by non-Federal interests as a complementary element to your plan.

As noted in the material you have furnished us for review, there are 1,220 acres of state-owned land within your 8,422 acre plan. Ownership of the state land is:

Natural Valley Area Designation	Acreage	
B	648	Metropolitan District Commission
G	77	Corrections Department
K	390	Mental Health Department
O	105	Department of Natural Resources (state Forest)

Colonel Frank P. Bane

Concerning the state-owned land (1,220 acres), my preference would be for the Commonwealth to negotiate a flowage easement in preference to Federal acquisition in fee. I believe that the present use and management of the land is fully compatible with your flood control requirements and that the Metropolitan District Commission, the Department of Natural Resources, and other state agencies would regard this alternative as the preferable.

In addition to the above state land, those lands currently managed by the Trustees of Reservations and the Massachusetts Audubon Society (429 acres), and those lands now in municipal conservation ownership (589 acres), should, in my view, remain in their present hands. It seems imperative that the noteworthy tradition of local and private stewardship now existing in this valley not be jeopardized by an arbitrary requirement for Federal acquisition. If necessary, comparable arrangements could possibly be made with respect to flowage easements.

It would be helpful, however, to enable a measure of Federal assistance under the provisions of Public Law 89-72 for recreational facility development should suitable opportunities materialize. At certain locations within the watershed, expanded opportunities for public use and enjoyment would not adversely affect either the flood storage requirements or the scenic and natural character of the river system.

The Commonwealth is also warmly supportive of the observation made by the Department of the Interior that the system of protected wetlands recommended by the Corps could enhance national wildlife refuge objectives. Again, I am of the opinion that these benefits could be obtained without the necessity of outright Federal acquisition through the easement approach suggested above.

Consideration should be given to coordinating the protection and management elements of the plan at a single level of government. Because of its own interest in lands along the banks of the Charles, its close relationship with municipal and private actions in this regard, and the variable nature of the required forms of protection, I can state that the Commonwealth is prepared to provide the requisite leadership in cooperation with the Corps of Engineers.

In summary, insofar as the authority of my office extends, I would like to express the state's willingness to concur with the Items of Local Cooperation as presented in your report. I urge you to complete action as soon as possible and to place this pioneering program before the Congress at the earliest possible date for authorization and implementation.

Sincerely yours,

Charles H. W. Foster
Secretary

CHWF:hw

MAR 3 1 REC'D

Sierra Club
New England Chapter
373 Huron Avenue
Cambridge, Massachusetts 02138

Mr. Arthur Doyle
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Sir:

The Sierra Club is a national organization of 120,000 members which was formed to promote the intelligent employment and conservation of the natural resources of the United States. The New England Chapter, headquartered in Cambridge, Massachusetts, has 4,000 members and is particularly concerned with environmental questions affecting the New England region.

The tentative proposals of the Army Corps of Engineers, New England Division, resulting from the 5 year study of the Charles River watershed have been carefully studied. Particular attention has been paid to the unique proposal to acquire 19 wetland areas, to be maintained in perpetuity in their natural state, as the most effective and economical means of acheiving flood control protection for the Charles River watershed. These areas have been designated "Natural Valley Storage Areas A through S" on the Corps maps.

The New England Chapter of the Sierra Club wishes to express its support for the Corps proposal to acquire the 19 wetland areas for preservation in their natural state. This program will serve the needs of the watershed for conservation of fast disappearing natural areas as well as flood control protection.

Sincerely,
Paul Swatek
Paul Swatek, Chairman

cc:Col. Frank P. Bane
Army Corps Of Engineers
424 Trapelo Road
Waltham, Massachusetts

Megonko Road
Natick, Mass. 01760
May 9, 1971

l. Frank Baine
rps of Engineers
4 Trapelo Road
ltham, Mass.

Re: Charles River Watershed Study

r Sir:

I am Shirley M. Brown, water chairman of the League of Women
ters of Natick. We are one of a group of 18 Leagues in the Charles
tershed who share in the Leagues'long standing national concern
water resources. We have studied and taken action in the field
water resources and in the specific area of the Charles River
nce 1963. The river is an important asset to our town and we are
tious to preserve and enhance its very great potential.

As a League, we have been involved in education and action for
tland preservation for purposes of flood prevention, and the pro-
tion of our drinking water supplies as well as to guard against
ther pollution of our lake, streams, ponds, and rivers; to assure
additional open space necessary for a community in an area under
eat pressure for growth. Our action was culminated this year in
option by the town of the concept of Flood Plain Zoning.

We laud the principle of using federal flood control funds for
quisition of natural wetlands to be preserved in their natural
te. In our town, we are concerned only that the plan has not
n inclusive enough. We feel strongly that area #10 (designated
ter conservation and open space in Natick) is a prime addition
natural valley storage. We also suggest that the headwaters
Indian Brook lying above designation E on the map is a necessary
natural wetland extension to the plan. These two areas would
m vital in any management of water and related land resources.
a compelling reason, I would cite the peak flooding of 18-25 March,
8, which threatened the bridge below the Natick dam site. In any
e, I would strongly urge that the study state the importance of
ural retention and restriction of these additional wetlands which
uld be preserved.

We are not convinced that impoundment by the Soil Conservation
rvices of area #1202 would be a desirable alternative to its
servation as a natural wetland because there would probably be
igh organic content to the water flowing into it.

We are greatful to the Corps of Engineers and the various
vernmental agencies involved for the depth and quality of the
formation they have researched and the opportunity for citizen
rticipation in the study.

Yours truly,

Shirley M. Brown

Mrs. Clarence Brown, Water Chairman
League of Women Voters of Natick

dlyn Eisenmenger

olyn Eisenmenger
ironmental Quality Chairman

MILFORD WATER COMPANY

MILFORD, MASS.

May 13, 1971

Department of the Army
New England Division
Corps of Engineers
Waltham, Massachusetts

Re: Echo Lake-Charles River

Gentlemen:

With recommendations about to be formulated by the Corps of Engineers regarding the Charles River, I thought it might be helpful to state the position of this company in regard to Echo Lake in Hopkinton and Milford. Echo Lake and the perimeter around it is owned entirely by the Milford Water Company. It is the main water supply for this company which presently serves approximately twenty thousand people. Demand on this system is growing quite rapidly due to growth of population in the service area.

The management of this company believes that Echo Lake could be increased in size, that it would be feasable to use it for such limited recreation as would be compatible with its long time and increasing use for water supply, and that this would be beneficial for all. There has been no public access up to this time and this has served to keep the area in a state that is unusual in this locale in these times.

In our plans to use it increasingly for water supply we have formulated some ideas about Echo Lake that I should communicate to you at this time along with thoughts that come to mind regarding multiple use.

1. In the normal use of the lake for water supply the level is drawn down, usually commencing about June 1st and ending about December 1. This would have to continue to the detriment of recreational use.
2. Because it is drawn down somewhat by the time of the hurricane season it does serve in a limited way for flood control. It did absorb over four feet of water before going over the top in the 1955 hurricane.
3. There is a need to conserve what water there is at Echo Lake thus shutting off flow of water from the lake except for water supply and except during Spring runoff over the spillway.

4. A plan, partially implemented by the Water Company, to run a large pipeline from the Dilla Street pumping station and from the Louisa Lake watershed to Echo Lake in order to make it possible to pump back to Echo Lake from below during Spring runoff in order to fill the larger reservoir that has been considered.
5. The advice of Milford Water Company sanitary engineering consultants to pump air to tubes on the bottom of the lake to achieve mixing of water layers and to increase dissolved oxygen in the deeper parts of the lake.
6. The attitude of the Massachusetts Department of Public Health regarding multiple use of a water supply.
7. The need to preserve the right of Water Company personel to regulate flow of water from the lake for water supply.

It would seem that the questions posed here could be resolved and the Water Company would be agreeable to entering into conversations with whatever agency is involved at a later date if and when the recommendations resulting from the Charles River Study are implemented. It does seem reasonable to develop the area further for multiple use in years to come.

If this information will help you in your final conclusions for the Charles River Study report, then that is my purpose.

Sincerely yours,

MILFORD WATER COMPANY

Robert T. Symonds
Manager and
Member Citizens Advisory Committee

Town of Weston

MASSACHUSETTS

Conservation Commission

To the Chairman, Coordinating Committee
for the Study of The Charles River Watershed
c/o New England Division Engineer
Corps of Engineers, U. S. Army
242 Trapelo Road
Waltham, Massachusetts 02154

Gentlemen:

This written statement will confirm the oral statement made by The Conservation Commission of the Town of Weston to your committee at the meeting held in Medfield, Mass. on May 13, 1971.

The Town of Weston is located on the Charles River Watershed. Our town has a severe problem that pertains to this study: pollution of our water supply and the Charles River.

The town's main source of water comes from a well located on an aquifer in the southeastern part of Weston in an area formerly known as Nickerson Field. This well was drilled in 1941 and has faithfully produced water at the rate of one thousand gallons per minute since that time. It has proved to be an excellent source of water. At the time it was placed in use it was tested by the Massachusetts Department of Public Health and had an insignificant chloride count. These tests have been made on a quarterly basis since that date and are a matter of public record. In May 1970 the chloride count of our well was over 300 parts per million which is above the state allowable standard and it was closed at the suggestion of the Department of Public Health. It has been out of service as a water supply since that time and our town has been forced to buy most of its water from the Metropolitan District Commission.

There were four significant changes in the aquifer's area since the date our well was put in operation. These are construction of state highway Route 128 in the early 1950's, the Massachusetts Turnpike in 1957, the relocation and widening of Route 128 in 1964 and the construction of the Massachusetts Turnpike, Boston Extension in 1964. Both these road systems use pure salt (undiluted) to combat winter driving conditions. Attached to this statement is a table indicating the chloride count increase in water from this well for the past fifteen years. We attribute this condition to the use of salt on these road systems that go through our aquifer and to the storage of salt in the area.

Our efforts to correct this situation have not been successful thus far. Our Hydrologist has determined that the source of pollution is located within our aquifer. We have approached both the Massachusetts Department of Public Works and the Massachusetts Turnpike Authority for help and assistance.

The Department of Public Works has been helpful to the degree that they are now erecting a roof and floor for their salt pile near the Riverside recreation grounds which is on our aquifer.

The Massachusetts Turnpike Authority in the past has made attempts by lining their run-off drains to reduce the percolation of salts into the soil of our aquifer. We most recently approached the Turnpike Authority in November 1970. We were promised by their chief maintenance engineer a report from their engineers embodying additional steps they would take to correct this situation by April 9, 1971, but as of this date, we have received no word from them.

As our situation now stands, the Town of Weston is forced to purchase most of its water requirements. We use annually approximately 420,000,000 gallons. Our charge from the Metropolitan Water District is $120.00 for each million gallons pumped.

The above, compounded by the loss of our fine well and water source illustrates the seriousness of our chloride pollution problem. It is equally significant that the water run-off of both of these road systems drains directly into the Charles River. This may add substantially to the river's contamination.

In view of the above, it is our recommendation that the report of this committee include a provision that salt on roads in the Charles River water shed be strictly limited and if possible completely eliminated.

Very truly yours,

Harold B. Willis, Jr.
Chairman

Attachment

Chloride Count - Nickerson Field Well - Weston, Massachusetts

	Parts per million
May 1956	13
May 1957	33
May 1960	32
May 1962	36
May 1966	166
May 1968	200
May 1969	250
May 1970	300 +

Cambridge Boat Club

GERRY'S LANDING ROAD
CAMBRIDGE, MASS. 02138

Colonel Frank P. Bane
Division Engineer
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Subject: Charles River Watershed Resources Investigation

Dear Sir:

I am a resident of Newton and am submitting this letter as President of Cambridge Boat Club, which is located on Memorial Drive at Eliot Bridge. This letter expands on my statement at the Public Meeting on May 13.

Cambridge Boat Club was incorporated in 1909 under the laws of the Commonwealth of Massachusetts, for the purposes of encouraging boating and maintaining a place for social meetings. The Club has a membership of 250 but, since many of these are family memberships, we serve directly a population of approximately 550. In addition, since we rent our Club House to appropriate groups and organizations for various social functions, our facility is utilized by a wide segment of the community. Most of our members live in Cambridge, Belmont and Boston.

The main activity of Cambridge Boat Club is rowing on the Charles in shells with one to four oarsmen aboard. Our oarsmen range from the business man escaping from the office for some needed recreation to the serious young rower of international standard. This summer we are conducting an Olympic Development Center to train rowers for the 1972 Games in Munich. This effort is being performed under a grant from the Olympic Development Committee.

My purpose in appearing at the Public Meeting and in submitting this letter is to place on record the position and interest of Cambridge Boat Club in regard to environmental quality in the Charles River Watershed. I would like to address in turn each of the areas you have delineated in the Meeting Announcement.

1. Flood Control. Our building is located on the banks of the Charles. We have a floating dock, as well as fragile rowing shells worth in excess of $15,000. We obviously would like to feel secure against the risk of flooding, since every time this occurs it necessitates removing all the shells to a safe location, as well as cleaning up the mess left by the water.

2. Navigation. Our rowers always operate on the "see and avoid" principle. Our boats are permitted on the river only in daylight. Our rowers generally keep close to the right bank.

The main difficulty we experience in regard to navigation arises from the fact that our boats are very sensitive to waves created by power boats. Our shells are easily swamped by a passing launch but this is fortunately rare.

The most common problem is the unsettling effect of the waves from power boats. The rowers just have to stop completely while a power boat goes by, and then wait for the waves to dissipate. This takes a considerable time in portions of the river with vertical masonry embankments.

On summer weekends it is essentially impossible to row after eight or nine in the morning when various and sundry power boats are on the river. We recognize that most power boat operators show us great courtesy in slowing down to pass us. We also recognize that rowing and power boating are both legitimate forms of water recreation. Ideally, however, power boating would be restricted to large bodies of water which are best suited for this activity and which happen not to be suited for rowing in shells. This would be a more rational allocation of resources.

3. Recreation. Naturally we would like to see the Charles River conserved for rowing. In the winter time we would like to see cognizant agencies do everything possible to encourage use of the Charles for skating, consistent of course with public safety.

4. Water Quality. Rowing does not contribute significantly to water pollution since the only power boats we use are the occasional coach's launch. Thus rowing is quite compatible with enclosed bodies of water such as the Charles.

Rowers do occasionally fall in the river. Thus, we would like to see the biological and chemical water quality maintained so rowers do not sustain illness or infection from contact with the water. Esthetically, of course, we do not like the river to become odoriferous. Finally, we would prefer the river to have a minimum of hard chemicals in it because of the damage these cause to shells and rigging. We recognize that the Charles River water quality has improved substantially in recent years, but there is still room for further improvement.

Another area of particular concern to us is floating debris. This is often hard to see in the water from the height at which the rower sits. Needless to say, when a shell meets a decent sized piece of drift wood, the shell suffers most. Boats can be completely ruined in one such encounter. We would like to see every possible step taken to prevent the disposal of floating solid waste in the Charles. Some of it, of course, is natural in origin, but most is dumped by man. This can and should be stopped. In a recent incident, two young men abandoned a raft they had made out of lumber and four large oil drums. This debris was still floating between the Eliot and Anderson bridges nearly a month later.

In conclusion, I'd like to express our appreciation for this opportunity to present our position on the future of the Charles River Watershed.

Sincerely yours,

Lawrence G. Copley
President

The Commonwealth of Massachusetts
University of Massachusetts
Amherst 01002

)LLEGE OF AGRICULTURE
CTION – RESEARCH – EXTENSION
DEPARTMENT OF
TRY & WILDLIFE MANAGEMENT
204 Holdsworth Hall

May 14, 1971

Colonel Frank P. Bane
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Colonel Bane:

I wish to be recorded in favor of the Corps recommendation to preserve extensive wetlands in the Charles River Watershed. As an ecologist leading an inter-disciplinary research study of freshwater wetlands, I welcome the Corps recognition of wetland flood control values.

While the relationship between flood control and wetland storage has been recognized, detailed engineering documentation has been somewhat lacking. It is to the credit of the Corps and the cooperating state and local agencies that in this instance the need has been met.

The Corps proposal is forward looking and precedent setting. I hope that it will become a reality and a model example for future national policy.

Sincerely yours,

Joseph S. Larson
Associate Professor of
Wildlife Biology

JSL:avb

The Commonwealth of Massachusetts
University of Massachusetts
Amherst 01002

EPARTMENT OF GEOLOGY
Morrill Science Center

Phone: 413-545-2286

May 28, 1971

Col. Frank P. Bane
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Bane:

I should like to be recorded as favoring the Corps' recommendation to preserve the wetland corridor along the Charles River. The Corps proposal is forward looking and I hope that it will become a reality in order to set a model for future national policy.

I hope that the method of flood control protection through preservation of floodplains and wetlands along the major rivers will receive more serious consideration as an alternative to the construction of dams and other flood control structures. Your Charles River plan will not only preserve a valuable natural resource but it will also mean that protection is provided forever.

Sincerely yours,

Ward S. Motts, A.I.P.G.
Hydrogeologist

WSM:kb

CITY OF WALTHAM

MASSACHUSETTS

OFFICE OF THE MAYOR
HONORABLE ARTHUR J. CLARK

May 28, 1971

Col. Frank Bane, District Engineer
United States Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts

Dear Col. Bane:

You have in your files a statement from Mrs. Harold M Burstein, Chairman of the Waltham Conservation Committee, which reasonably states the unhappiness of the City of Waltham relative to the deletion of Storage Area "A" from the proposed Natural Storage Areas. The fact that the areas may not quite meet the pre-determined criteria of 100 acres in private hands should not militate against the area. Rather, the fact that some of the 100 acre area is in State hands should be treated positively, since it makes the gross acreage cost less per unit.

More agressive analysis also could substantially increase the potential area by moving upstream into the area above Route 2, where another flood plain axists.

I hope most sincerely that you will restore Area A and expand it as suggested.

Very truly yours,

Mayor

AJC:McC:c
cc: Congressman Drinan
cc: Mrs. Burstein

West Roxbury Historical Society

WEST ROXBURY, MASSACHUSETTS 02132

May 31, 1971

Col. Frank P. Bane
Corps of Eng., Dept. of the Army
Waltham, Mass.

re: NEDED-R

Dear Sir:

The meeting in Medfield on May thirteen was helpful, informative, interesting. Thank you.

The ways and means to cope with the problem of the Charles River Watershed, as presented by the Department of Natural Resources, the Metropolitan District Commision and the Army Corps of Engineers, are in close enough agreement to allay the apprehensions of those most directly involved. Limiting recreational use of Open Spaces to such activities as will not upset the Natural Wilderness characteristics and life of the area is urged.

Todays technology is so fast--so powerful--and of such frightening force, we had better learn to control it before it gobbles us up!! We haver't time for hind-sight nor can we afford the astronomical costs of trying to correct mistakes which so often prove irrevocable. We need to define "what IS progress?" Convenience? Pleasure? Profit? Things? What of people? their happiness, welfare, survival? What of our EARTH? exploit it? We MUST treasure it lest it become as barren as the Moon--inhabitable.

The West Roxbury Historical Society is particularly concerned with a small area but a great big head and heartache. The east side of the Charles from Dedham circle along 'Honky-Tonk Hghwy to the Newton line, is a prime example of what happens when profits come before people needs and present expediency leads to irreparable loss (the dump).

The Charles River-Sawmill wetlands and meadows not all ready misused still retain much of their natural wilderness character and should be preserved inviolate from further encroachment by land-fill or excavation--public or private. Included in that area are Brook Farm and Pulpit Rock, both of which have been designated National Historic Landmarks. The WRHS would like to see established a Mini-Historic and Natural Wilderness Trail in this area bounded by the Charles on west-Newton line on north-Baker Street, VFW Pkwy on east-railroad right-of-way on south.

With the support of local community and civic organizations the MDC has been asked to acquire this Sawmill area by eminent domain and that further desecration of Open Spaces be stopped NOW. Yesterday was none too soon---tomorrow can be too late.

West Roxbury Historical Society does not have the resources to purchase but are ready and willing to be involved and to help with uses and maintenance to whatever extent it can do so.

Sincerely yours,

Mrs. Charles J. Feeney
200 Temple Street
West Roxbury, Mass. 02132
323-8628

president

CITY OF BOSTON
DEPARTMENT OF HEALTH AND HOSPITALS

818 HARRISON AVENUE
BOSTON, MASSACHUSETTS 02118

Tel. No. _____

June 1, 1971

Army Corp of Engineers
New England Division
424 Trapelo Road
Waltham, Mass.

Gentlemen,

I am writing you at the request of the Executive Committee of the Dedham Friends of Conservation in support of your proposed land taking along the Charles River in the Town of Dedham. These areas are constantly threatened by adjacent developers and repeated infractions of the floodplain zone have occured. The Town of Dedham,as you know, had already instituted land taking proceedings in at least, one of the areas under consideration in your present plan.

The Executive Committee is enthusiastic in it's unanimous endorsement of your plan and if we can be of further help to you in this matter, either by providing further information or by our presence at future hearings we will be happy to do so. If I can help you in this matter, please let me know.

Sincerely,

J. F. O'Connor, J. D.
President
Dedham Friends of Conservation
106 Ledgewood Road
Dedham, Mass.

LEAGUE OF WOMEN VOTERS OF WALTHAM

WALTHAM, MASSACHUSETTS 02154

1st June 1971.

Colonel Frank P. Bane,
United State Army Corps of Engineers,
424, Trapelo Road,
WALTHAM, Mass. 02154.

Dear Sir,

re: Charles River Study.

The League of Women Voters of Waltham has, and will continue in its endeavour to protect the water resources of the city.

The knowledge of the history of flooding of Beaver Brook and the substantial damage incurred by residents in this area is of major concern to us. We strongly urge you to reconsider your decision regarding wetland 'A' although this is smaller than the other wetlands in your proposals for the Charles River Watershed. We feel that unless this wetland is protected from development the citizens of Waltham further down stream will suffer further hardship. Unfortunately we have not yet been able to institute Flood Plain Zoning in the City of Waltham, but should wetland 'A' be included in your proposals this would give us a tool with which to work.

We noted the remarks by the residents of Millis at the hearing on the 13th May at Medfield —— " We in the upper reaches of the Charles are being asked to give up acres of land to protect the cities and towns further down stream, but they seem to be building on every inch of their land". We appreciate their concern and would therefore, like it to be on record that we in Waltham would like to help ourselves in some small way, and perhaps the inclusion of wetland 'A' would show the upper Charles River residents that this is indeed the case.

Yours truly,

Verona M. Peters,
Chairman,
Water Resources Committee.

CITY OF WALTHAM

MASSACHUSETTS

THE CITY COUNCIL

PRESIDENT
JOSEPH T. MAGUIRE

COUNCILLORS-AT-LARGE

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9. THEODORE W. SUMNER

June 7, 1971

Colonel Frank P. Bane
Division Engineer
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

I wish to be recorded in favor of the statement made by Mrs. Harold M. Burstein, Chairman of the Waltham Conservation Committee at your public hearing on May 26, 1971.

As Ward 4 Councillor which includes Linden Street, Waverley Oaks Road, Beaver Street etc., I am well aware of the flooding problems at Beaver Brook. Since the upstream marches are being planned for development, we have no other recourse but to expect further flooding within my ward.

I therefore respectfully request that you review area "A" before the final recommendations are sent onto Congress.

If I can be of any assistance in this regard, please do not hesitate to contact me.

Very truly yours,

Joseph D. Goode

JDG/tm

Natick Environmental
Concerns Commission
24 Main St.
Natick, Mass. 01760
June 8, 1971

Col. Frank Bane
Dept. of the Army
New England Division, Corps of Engineers
424 Trapelo Rd.
Waltham, Mass. 02154

Dear Col. Bane:

The Natick Environmental Concerns Comm. is a group formed by the Town Meeting to work for the town in the area stated in our title. Thus we are interested in the Charles River Watershed Study.

The ECC wishes to go on record as supporting the Army Corps plan for protecting naturally existing wetlands in the Watershed for the purposes of flood control, recreation, ground water maintenance and so forth.

We believe it is of unprecedented significance that the Corps has recommended protection of wetlands for flood control, and agree that such protection is the least expensive and most efficient method, as compared to artificial controls such as dams.

We also believe that where possible, conservation easements should be obtained instead of purchasing wetlands. If such easements cannot be secured, we do of course support purchasing.

The Citizens' Advisory Group's recent presentation of your plan in Natick went relatively unnoticed because of lack of adequate advance publicity. We hope that you will plan better publicity and citizen education in Natick and other towns to gain more public support, and we will be most happy to cooperate as needed.

Thank you for the opportunity to voice our opinion.,

Respectfully,

A. Richard Miller

A. Richard Miller, Chairman
Natick ECC

HARRISON A. WILLIAMS, JR., N.J., CHAIRMAN.
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STEWART E. MCCLURE, STAFF DIRECTOR
ROBERT E. NAGLE, GENERAL COUNSEL

United States Senate

COMMITTEE ON
LABOR AND PUBLIC WELFARE
WASHINGTON, D.C. 20510

June 11, 1971

Colonel Frank P. Bane
Chief, New England Division
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Colonel Bane:

I want to express my support of the objectives of the Army Corps of Engineers on the plan to protect and preserve areas in the Charles River Watershed for recreation and environmental enhancement. It seems to me that the use of natural means to protect our natural resources is the most effective and the least costly method of preservation. I agree that the citizens living in the area should profit both because their quality of life will be improved and ultimately their property values increased. To have beautiful wooded areas and a clean river so accessible to the urban population seems to me to be an ideal situation.

I hope that the Army Corps will continue to meet with the affected citizens of the area. The concerns of these residents the pollution potential of the water impoundment areas, I am sure will be thoroughly investigated before any action is taken.

I look forward to working with you on this project. Please let me know if I can be of assistance.

Sincerely,

Edward M. Kennedy

The Trustees of Reservations
224 Adams Street
Milton
Massachusetts
02186

Telephone
617-698-2066

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John M. Woolsey, Jr
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Deputy Director
Nathan W. Bates
Coordinator of Reservations

The Trustees of Reservations is a privately-administered charitable corporation chartered for conservation purposes in 1891 to preserve for the public places of natural beauty and historic interest within the Commonwealth of Massachusetts. Contributions are deductible under Federal income tax law.

June 11, 1971

Colonel Frank P. Bane
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Colonel Bane:

The Trustees of Reservations is a charitable corporation founded for conservation purposes in 1891, to preserve for the public, places of natural beauty and historic interest.

Today, The Trustees of Reservations are custodians for 53 open space and historic areas from the hills of Berkshire County to Cape Cod. They total more than 11,000 acres.

Nine of these areas are located in the watershed of the Charles River. They are Rocky Narrows Reservation in Sherborn, 53 acres; Pegan Hill Reservation in Dover and Natick, 32 acres; Charles River Peninsula in Needham, 29 acres; Medfield Rhododendrons in Medfield, 190 acres; Rocky Woods Reservation in Medfield, 431 acres; Fork Factory Brook in Medfield, 62 acres; three Meadow Lots in Medfield, 16 acres; the Henry L. Shattuck Reservation in Medfield, 269 acres; and Noon Hill Reservation in Medfield, 25 acres. This represents a total of some 1,107 acres. Obviously, our interest in the Charles River valley and its natural environment is immense.

That is why we welcome this opportunity to comment on the Charles River Study prepared by the Department of the Army, New England Division, Corps of Engineers.

First, we support wholeheartedly the Corps' proposal to create natural valley storage areas for flood control in the Charles River valley. We are impressed with the study's emphasis on preserving the integrity of the area's natural environment. It is totally consistent

with the growing need for open space within the metropolitan area and it will help maintain the landscape character and beauty of the Charles River corridor which means so much to the quality of life within its communities. We are also impressed, quite candidly, with the economic advantages of the natural valley storage proposal.

Second, however, we would like to express concern about several areas which we believe are directly related to the success of the project proposal.

The first involves pollution control and water quality standards. We believe that a pollution abatement program should begin immediately under the jurisdiction of state and local agencies. We also believe that planning should begin for regional sewerage districts in the upper Charles River valley, and that the disposal of solid wastes should be coordinated as well in a regional program.

We are concerned, second, with the management of the flood plain in the upper watershed. Statistics show that the 17 natural wetland storage areas will utilize some nine percent of the 184 square miles of watershed land. We believe careful planning should be initiated immediately which will lead to proper land use controls for the remaining 91 percent of land area. Without these controls, the entire project will be in jeopardy. They are essential to the over-all plan.

Three, we are concerned about the role and responsibility of the various Federal, state, municipal and private organizations within the Charles River watershed, each engaged in the protection of the area's natural environment. They are, most particularly, the Corps itself, the U.S. Department of Agriculture's Soil Conservation Service, the Massachusetts Department of Natural Resources, the Metropolitan District Commission, The Trustees of Reservations and the Massachusetts Audubon Society. There are, of course, private landowners as well whose interests run parallel to all of ours.

We feel there should be a careful definition of roles and detailed coordination of objectives in the acquisition and preservation of land for natural water storage. A multiplicity of agencies and overlapping jurisdictions could, unless responsibilities are carefully and specifically defined, result in confusion and even chaos which could seriously inhibit positive action.

Four, we hope in relation to the above, that the Citizens Advisory Committee will continue in existence to provide a clearing house for information and an opportunity for discussion as the action phase of study begins.

Five, we are also, quite naturally, concerned about our own direct relationship with the Corps' Charles River study proposals and plan to follow up this letter with a personal meeting with Corps' representatives. Much of our land is specifically involved and a clarification of our future in the overall project is of vital necessity.

Finally, we thank you for this opportunity to comment upon the Charles River study and we again congratulate the Corps on its proposals to control flood damage in an area of growing urbanization. They show a vital concern for the environment and a sensitive sympathy for natural forces which sets an example for all Federal agencies.

Thank you again.

Most sincerely,

Gordon Abbott, Jr.
Director

GA,Jr.:bb

ROBERT F. DRINAN
3D DISTRICT, MASSACHUSETTS

CANNON HOUSE OFFICE BUILDING
PHONE: 202-225-5931

COMMITTEES:
JUDICIARY
HOUSE INTERNAL SECURITY

Congress of the United States
House of Representatives
Washington, D.C. 20515

DISTRICT OFFICES:
76 SUMMER STREET
FITCHBURG, MASSACHUSETTS 01420
PHONE: 617-342-8722

681 MAIN STREET
WALTHAM, MASSACHUSETTS 02154
PHONE: 617-891-9466

June 18, 1971

Colonel Frank P. Bane
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Colonel Bane:

The attached letter was sent to me by Mrs. Harold M. Burstein, Chairman of the Waltham Conservation Commission.

As Mrs. Burstein testified at the recent hearing on the Charles River Study, the Waltham Conservation Commission strongly feels that natural flood plain areas in the up-stream marshes must be preserved and protected and therefore the Charles River Plan should include such considerations.

Would you kindly review Mrs. Burstein's recommendations and advise me as to what actions might be taken.

Cordially yours,

Robert F. Drinan

Robert F. Drinan
Member of Congress

RFD/bbh

Enc.

Reply to: 76 Summer Street
Fitchburg, Massachusetts 01420

CITY OF WALTHAM

MASSACHUSETTS

36 Riverside Drive
Waltham, Ma. 02154
May 20, 1971

The Honorable Robert F. Drinan
509 Cannon House Office Building
Washington, D.C. 20515

Dear Congressman Drinan:

Enclosed is the statement I made on behalf of the Waltham Conservation Commission before the Army Corps of Engineers on May 13, 1971 at the time of their final public hearing on the Charles River Study.

We are sending it to you with the map showing the area designated as natural valley storage area "A", because we sincerely feel that this should be included in the recommendations of this study. There is no question of the severity of the flooding experienced in the past, and the statements made by the Army personnel indicate that there will be more serious flooding in the future if these areas are not preserved.

Unfortunately, we must recognize the weaknesses inherent in relying on the local governments to preserve these wetlands since all communities are feeling the pinch of diminishing land for development, and the educational process concerning the conservation of these areas moves slowly and far behind the developer's bulldozer.

We trust that you might be able to assist us in getting this area reconsidered by contacting Colonel Frank P. Bane, Division Engineer, Army Corps of Engineers, 424 Trapelo Road, Waltham, Ma. 02154 within the next few weeks. They will be accepting any written public statement for thirty days following the public hearing.

Thank you very much for your interest and assistance.

Sincerely yours,

Eunice K. Burstein

Eunice K. Burstein, Chairman
Waltham Conservation Commission
(Mrs. Harold M.)

Enc.

Mrs. Roger E. Spear
Community Improvement Program
7 Lincoln Circle
Wellesley Hills, Mass. 02181

16 Sagamore Road
Wellesley Hills, Mass.
June 25, 1971

U. S. Army Corps of Engineers
Waltham
Massachusetts

Gentlemen:

The Executive Board of the Wellesley Hills Woman's Club gives enthusiastic support to the plans of the Army Corps to save the wetlands to hold water along the Charles River by setting aside certain areas.

It supports the program for reservation of some 11,000 acres along a mile wide corridor extension a half mile on each side of the river from the Watertown dam to Echo Lake and the plan to protect and preserve an additional 11,000 acres for storage and recreational facilities.

Yours very truly,

(Mrs. Roger E. Spear) Counselor
Community Improvement Program
Wellesley Hills Woman's Club

48 Alpine Street
Cambridge, Massachusetts 02138
September 17, 1971

ol. Frank Bane
.S. Army Corps of Engineers
24 Trapelo Road
altham, Massachusetts

ear Col. Bane

The draft section of the Charles River Study entitled "Appendix Impoundments and Tributary Watersheds" prepared by the Soil Conervation Service has been submitted to me for comment. As a memer of the Citizens Advisory Committe there are certain sections upon hich I would like to submit my views.

The S.C.S. has retained 5 areas for proposed dams and impoundment ools. The Hopkinton pool (#905) is a cold water, relatively deep ool (average depth 27.1 feet) to be used for public water supply. reservoir already exists on the site. The other 4 pools (#'s 904, 07, 912, and 1105on the S.C.S. maps) are all to be created by damming reams and flooding wetlands. All are listed for warm water fishing.

Two pools are particularly shallow: #904 (Milford) with an average epth of 5.8 feet, and #912 (Franklin, Wrentham) with an average epth of 6.1 feet. This latter pool also conflicts with the Corps Engineers projected Natural Valley Storage Area D. This conflict s a direct contradiction of statements made by S.C.S. representatives the April 12 co-ordinating committee meeting that all impoundment ools conflicting with natural valley storage areas would be dropped.

I would like to state my opposition to the construction of the 4 rm water impoundments. Your own chief environmental planner stated the April meeting that these pools would be likely to support very eavy concentrations of algae growth due to phosphate pollution from ousehold detergents and agricultural runoff, the effect of the sun shallow relatively stagnent water and muddy bottoms. The recently sued report of the Massachusetts Division of Water Resources points ut that 3 recently constructed similar impoundments now constitute some the the most signifigant sources of biological oxygen demand on e river due to the excess algae growth.

The wetlands to be flooded by these pools now serve as a rich habat for animal and bird life. Their water storage capacity helps otect the lower watershed in time of heavy rains. It is true that eir current recreational potential is limited. The asserted recation potential of the proposed pools should be closely examined, wever.

Total recreational benefits of $325,200 are claimed. This repreents 83% of the total annual benefits from all sites. (Table 1-2)

These benefits are based on 216,895 user days (Table 6-2). All three of the recreational activities listed (excluding swimming and boating which were not included in the user day totals) are independent of the creation of the impoundment pools, however.

Picnicing is listed for 58% of the user days. This would seem to assert that lakes should be built so people can have something pleasant to look at when they eat lunch. Unless the water level is very constant, the shallow gradients of the proposed pools will result in unsightly mudflats, especially in the summer months when picnics are usually held. In any case, the pools are not needed for the construction of picnic areas.

The connection between the other two activities, camping (7% of user days) and hiking and/or nature study (35% of user days) is also tenuous at best. In fact, the pools will remove considerable land from potential hiking or nature study by putting it under water. The limitations on recreation potential because of the marshy nature of the wetlands to be flooded is not lessened by flooding the area. Building the pools does not enhance the hiking and nature study potential of the rest of the area.

If these factors are carefully considered: the danger of pollution problems because of excessive algae growth; the unsuitability for swimming of shallow, warm, mud-bottomed pools; and the questionable basis on which the recreation benefits are postulated, the arguments for the proposed impoundments are unimpressive.

I urge that the issues stated in this letter be submitted to the S.C.S. for their consideration in writing their final draft. As head of the Charles River Study I urge you to disapprove the recommendation for the 4 warm water pools.

Sincerely,

Alan R. Minoff

cc: Mr. Thomas Cabot, Chairman
Citizens Advisory Committee
Mrs. Lydia Goodhue, Member
Citizens Advisory Committee
Mr. Richard Heller, Chairman
Pollution Group, Eastern Massachusetts Sierra Club

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
U. S. POST OFFICE AND COURTHOUSE
BOSTON, MASSACHUSETTS 02109

FEB 1 ; 1972

Division Engineer
New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

Colonel Bane's letter of January 6, 1972, requested our comments on draft copies of the "Main Report" and Appendices "A" and "C" of the Charles River Study. This letter contains our comments on the drafts, and amplifies comments in the third paragraph of the Bureau's letter to you dated December 16, 1971.

The Bureau of Sport Fisheries and Wildlife plans to accept management of the Natural Valley Storage Areas as a part of the National Wildlife Refuge Program. As a result, the following revisions of your drafts appear appropriate.

1. Fee and Easement

We understand that the seventeen Natural Valley Storage Areas amount to 8,422 acres, of which 6,184 acres are owned privately. It is my understanding that at this time it is not known how much of the private land will be acquired in fee title and how much will be regulated by easements. The Bureau would prefer that land to be managed as part of the National Migratory Waterfowl Program be acquired in fee title. We understand, however, that landowner resistance to selling the land may result in the necessity of easements on some of these lands. These easements must be comprehensive in nature, to provide the Bureau adequate authority to manage the lands and to permit public access. Thus, the easement prepared, appearing on Pages H-19 and H-20 of Appendix H, will have to be modified to reflect this.

The permanent easement which should be obtained would not only restrict filling and alteration of flood storage, but would include Bureau management and

development to maximize fish and wildlife resources. The Bureau should have the right to restrict or permit public access and such activities it deems necessary to carry out its primary programs. The easement should permit wildlife habitat manipulation, excavation of potholes, creation of waterfowl areas with dikes and levees, installation of nature trails and outdoor education facilities, and necessary structures and facilities to operate a Federal refuge. It is also recommended that the title of the easement be changed to reflect the fact that it is not a simple flowage easement.

2. Disposition of Lands Acquired

This item is mentioned on Pages 55 and 56 of the "Main Report" and on Page H-26 of Appendix "H".

Both reports contain mention of two options for disposal of lands. We suggest that the reference to the option of disposal to the Commonwealth of Massachusetts for management of said lands be omitted to prevent confusion.

We believe the title "Disposition of Lands to be Acquired" is misleading. The title implies disposal of ownership to other than the Federal Government (in the case of acquired lands) and omits any mention of what will happen to easement lands. I believe a better title would be "Management of the Natural Valley Storage Areas". Establishment of a National Wildlife Refuge for land maintenance, management, and development can then be included in the paragraph and it should be revised to include both fee and easement lands.

3. Benefits to Land Acquisition

An Outdoor Recreation and Environmental Conservation benefit of $439,000, based on the value of acquiring land, is shown on Pages H-28 and H-29 of Appendix H, and on Pages 64, 65, and 66 of the "Main Report". Benefits shown in our report should be included or added to these benefits. An advance copy was provided your agency.

4. Intangible Benefits

This item occurs on Page 64 of the "Main Report" and on Page H-28 of Appendix H.

It is recommended that the intangible benefits which will be derived by including this area in the National Wildlife Refuge Program be inserted. Such benefits would include also the perpetual

maintenance and enhancement of the area for all fish and wildlife species, including songbirds, and aquatic and terrestrial mammals. The existing national and regional need for these resources is evident in the concern expressed by the public to preserve them.

The following comments pertaining to the "Main Report" are provided for your consideration:

Page 31, 2nd Paragraph, 2nd Sentence

We suggest this sentence be revised to read, "Adequate fishways are lacking at most of the existing dams. Dramatic improvements in water quality must be made before the Charles River will support its full potential of anadromous and resident fish species.

Page 43, 3rd Paragraph, 1st Sentence

It is suggested that this sentence be modified to read, "The Committee also finds there is need for construction of necessary fish passage facilities, and the existing facilities should be kept in good operating condition. At the same time the Committee finds there is a need to maintain existing dams along the Charles River."

Page 44, 3rd Paragraph, 3rd Sentence

We recommend the words "American Smelt" be deleted from this paragraph.

Page 46, Last Sentence Ending at Top of Page 47

It is suggested that this sentence be revised to read, "A fish passage facility will be included to afford immediate access to habitat upstream to the Bleachery Dam at River Mile 11.8, since the fishery at the Watertown Dam will be reconstructed in 1972".

Table 10, Following Page 53

An expenditure of $950,000 is listed for construction of fish ladders. This figure has been reduced to $870,000.

Page 55, Last Sentence (continuing to top of Page 56)

We understand that your personnel plan to revise this sentence to more accurately indicate the Bureau's interest as expressed herein.

Page 58, Second Paragraph

We would like to suggest that this paragraph be amplified in order to indicate that the Bureau may be interested in adding appropriate lands located outside the Natural Valley Storage Areas. Appropriate lands are areas of current high fish and wildlife value, having a development potential suitable to the Bureau's needs. These lands will be in varied ownerships, and amount to approximately 11,580 acres of wetlands.

We have no comments to offer on Appendixes "A" or "C". We appreciate the opportunity to comment on these drafts.

Sincerely yours,

Richard E. Griffith

Regional Director

LOCATION MAP

SCALE IN MILES
0 10 20 30 40 50

N

MERRIMACK RIVER BASIN (SHAWSHEEN)

MYSTIC RIVER BASIN

CHARLES RIVER (SUDBURY-CONCORD) BASIN

MERRIMACK RIVER BASIN

BLACKSTONE RIVER BASIN

TAUNTON RIVER BASIN

NEPONSET RIVER BASIN

CHARLES RIVER DAM
AUTHORIZED 1968
UNDER DESIGN

CONCORD · LEXINGTON · WINCHESTER · LINCOLN · MEDFORD · ARLINGTON · BELMONT · SOMERVILLE · EVERETT · WALTHAM · WATERTOWN · CAMBRIDGE · WESTON · WAYLAND · NEWTON · BROOKLINE · BOSTON · WELLESLEY · FRAMINGHAM · NATICK · NEEDHAM · ASHLAND · DOVER · DEDHAM · MILTON · SHERBORN · HOPKINTON · WESTWOOD · HOLLISTON · MILLIS · MEDFIELD · WALPOLE · NORWOOD · CANTON · MILFORD · MEDWAY · NORFOLK · Hopedale · MENDON · FRANKLIN · BELLINGHAM · WRENTHAM · FOXBORO · BLACKSTONE · WOONSOCKET · CUMBERLAND · PLAINVILLE

905 · 907 · 904 · 1105 · 912

A · B · C · D · E · F · G · H · I · J · K · L · M · N · O · P · R · S

LEGEND

CORPS OF ENGINEERS - U.S. ARMY
- NATURAL VALLEY STORAGE AREAS
- BIKEWAYS
- ① CANOE LAUNCH SITES

DEPT. OF NATURAL RESOURCES - MASS.
- CHARLES RIVER CORRIDOR PLAN

SOIL CONSERVATION SERVICE - U.S. AGR.
- CONSERVATION POOLS
- CONSERVATION AREAS

SCALE IN FEET
5,000 0 5,000 10,000 15,000

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK. BY
J.J.C.		J.J.C.

SUBMITTED: Arthur P. Doyle — PROJECT ENGINEER
REVIEWED: Lawrence J. Bergin — CHIEF, COMP. RIVER BASIN SEC.
APPROVAL RECOMMENDED: — CHIEF, PLANNING BRANCH
APPROVED: Major L. Walton — CHIEF, ENGINEERING DIVISION

WATER RESOURCES INVESTIGATION
CHARLES RIVER STUDY
COORDINATE WATERSHED PLAN
CHARLES RIVER — MASSACHUSETTS

DATE: APRIL 1972
SCALE: AS SHOWN
DRAWING NUMBER
SHEET

TO ACCOMPANY REPORT
DATED: APRIL 1972

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